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THE ADJUTANT BIRD.

ONE of the most remarkable members of the stork family is the adjutant bird or argala, of India, which belongs to the genus Leptoptilus, and is a native of Asia and Africa. This bird is called the adjutant by the English from its resemblance at a distance to an officer with a white waistcoat and breeches. It is very common in India, and in Bengal each adjutant bird is believed to be possessed of a soul of a Brahman. The subject of our engraving is a picture by Hans Knöller entitled "The Art Critics," in which five of these immensely dignified birds are examining a sketch in oil left by some artist, while two more birds in the distance are deciding whether they shall come up and join in the discussion or not. The voracity of the adjutant bird is extreme, and is exercised upon anything which comes in its way, with little judgment; so it is likely that the paint upon the palette and not the sketch is the subject of the discussion between the birds. The bills are hardly adapted, however, for eating paint from a palette. There are undoubtedly fresh tubes of paint in the box which will also be divided and eaten in due time.

The Asiatic marabou, or adjutant, is a very large bird, measuring from the point of the bill to the claws 7½ feet and its expanse of wings is nearly 15 feet; it stands about 5 feet high. The bill is about 2 feet long, is straight, strong and sharp pointed. The head and neck are nearly bare of feathers. The back and wing coverts are a deep bluish ash, the feathers of the sides beneath the wings and those of the vent and under tail coverts are whitish, downy and about 12 inches long, and are so light and delicate as to command a high price for use for personal adornment. This bird seems to have been provided by nature with an exquisite feather boa of ample proportions. These feathers are extremely light and fluffy; a feather a foot long and 7 inches wide weighs only 8 grains. The services of the adjutant bird are very valuable as a scavenger and its presence is encouraged. It has even been domesticated. In their wild state they live in small flocks near the mouths of rivers. Their power of flight is very great and their vision is keen. The attitudes assumed by the adjutant are varied. It will remain in odd attitudes for a considerable time immovable, as if carved in stone and as grotesque as a gargoyle. Sometimes it squats on the ground with its legs tucked under its body and sits looking about it with a superb air of dignity, as of an enthroned monarch. When angry it stalks menacingly along, its neck stretched to the utmost, its head thrust forward and its huge bill open. It is then, indeed, a very formidable looking creature, but, unfortunately, it is a most cowardly bird, and this assumption of valor is only put on, for it will run away from a child if boldly faced. Serpents, however, fall an easy prey to this bird, who has a fashion of knocking them over before they can strike, and, after bruising them to death, swallows them whole. During the inundation the adjutant bird is invaluable, as it follows the course of the rising waters and makes prey of the reptiles that are driven from their holes by the flood. The capacity of the adjutant's stomach is something enormous. It will swallow a whole joint of meat or even a tortoise. It is easily tamed and soon attaches itself to a kind owner. In the late Rev. J. G. Wood's natural history an amusing account is given of an instance where one of these birds was domesticated and was accustomed to stand behind his master's chair at dinner time and take its share of the meal. It was, however, an incorrigible thief and was always looking for some opportunity for stealing provisions, so that the servants were forced to keep watch over the table with sticks. In spite of this vigilance, it was often too quick for them, and once it snatched a boiled fowl off the dish and swallowed it on the spot.

For our engraving we are indebted to Illustrirte Zeitung.

THE ADJUTANT BIRD.

THE first known coin is Chinese. It is copper, and specimens weighing from one to five pounds, and supposed to date from a period at least 2,000 years before Christ, are still in existence.

HOUSEHOLD INSECT PESTS.

THE paper recently presented by Mr. A H. Kirkland before the Boston Scientific Society was entitled "Our Household Insect Pests," and was an extremely practical paper. The speaker did not claim to bring forward any new facts, but was rather in this instance an arranger and collator of facts already known. In bringing together with the sanction of scientific authority the established facts with reference to the household pests, the paper has its value.

"No housekeeper, however excellent," said Mr. Kirkland; "no house, however well built, can exclude these pests; Yale locks and burglar-proof shutters are of no avail against such small organisms, and buffalo bugs and moths will creep in and destroy. The problem is not so much how to keep them out, as how to fight them." The paper proceeded without too much scientific description, giving the essential points in the life history of each of the insects, and suggesting the best means with which to oppose its ravages.

The buffalo beetle (Anthrenus scrophulariæ) is supposed to have been introduced into this country about twenty years ago, and since that time it has spread over the central and eastern part of the country and has become a common household pest. In Europe it is to be found on the blossoms of the shad-bush, but here it frequents the blossoms of the white daisy and the spiræa and is undoubtedly carried into the house upon these flowers. The beetle itself is a small, nearly elliptical creature about three-sixteenths of an inch in length, black, with white and yellowish-brown markings.

These beetles lay eggs upon carpets, rugs, and elsewhere, which after a short time hatch into small hairy grubs or larvæ. It is in the larval state that its depredations are committed. It feeds without discrimination upon carpets, clothing, furs, hair, and even horn and plug tobacco. When the worm is full grown it pupates, hiding itself in cracks in the floor and baseboards, and in from two weeks to two months, according to the temperature, it emerges and lays eggs

for the next brood. It requires about a year to complete all the stages of development.

There are a thousand and one patent nostrums which are offered for the destruction of this pest, usually vile-smelling liquids, and as a general thing these have no value. In furniture and clothing the application of naphtha or benzine with an atomizer or by flowing on is a certain remedy. In the use of these volatile hydrocarbons it is important that the greatest precautions be taken to guard against fire, and in the winter time this process would be decidedly unsafe in a furnace heated house. For carpets, the most convenient exterminator is live steam. If this can be applied to the carpet under some sort of hood, the best results may be expected. A substitute, which is quite efficacious, may be had by laying upon the floor some wet clothes and passing a hot flatiron over them. The steam will be driven through the carpet and any insect life contained in it will be destroyed.

The buffalo beetle has been trapped, it is said, by the placing of flannel, the best color for which is red, in some adjacent closet, and an occasional examination of this will lead to the destruction of many of the larvæ. For collections and in some cases for furniture, corrosive sublimate in alcoholic solution may be applied.

During the last year Mr. Kirkland has received from different persons in the city a curious centipede (Lithobius), which had been found in some of the houses on Beacon Hill and in the State House itself. This, however, is not to be dreaded, but on the contrary is an enemy of the buffalo beetle and, since it does not destroy carpets or cloth materials, it may very well be cultivated as a destroyer of the pest. The animal is related to the earwigs; it is small, active and of a bright red color.

Directly associated with the buffalo bug is the clothes moth. There are three species of these in this country with similar habits and proclivities. This is also an insect imported from Europe—all our pests seem to come from that continent—and it is because they are here under a different environment and freed from many of the enemies which attack them there that they are really pests with us. One of the three species builds long, narrow galleries through the fabric which it attacks; another works for itself a tube or house, and the third covers itself with a silken web, beneath which it eats away at the cloth. The caterpillar has two silk glands in its body, the apertures of which lie beneath the mouth. With these it spins itself some sort of covering. The tube spinner works the morsels of cloth which it detaches into the covering, fastening them together with the silk. Professor Fernald of Amherst, taking advantage of this peculiarity, has repeatedly performed a curious experiment. Placing the worm upon cloths of different colors for short periods, the animal has been induced to work these different colors into its tube, and appears as a veritable harlequin among moths.

When the tube becomes too small in bore to contain the worm, it cuts for itself V-shaped notches which it fills in with material, continuing to do so until it has reached the height of its development. It then spins a cover for the tube and in this it passes through its pupa stage.

The moths fly through the house in April and sometimes as late as August, seeking places in which to deposit their eggs. These are laid to the number from twelve to seventy-five, which when hatched give white worms which devote their lives, as do other worms, to the devouring of food.

The same remedies are efficient against all three species. Cedar, naphthaline, tobacco, camphor, etc., are not remedies. The odor of these substances may prevent the female from laying her eggs in some particular spot, but if the eggs are really laid, these substances, were they many times stronger in odor, would not have any effect upon the voracity of the grub. For clothing, the safest way is to seal up garments, furs, etc., in paper bags or boxes, being careful to beat them and free them from moths or eggs. If put away before the moths begin to fly, no eggs will be in them. Professor Howard, of Washington, recommends for this purpose the large pasteboard boxes commonly used by tailors for the delivery of garments, the lapping of the cover being made tight by the use of strips of gummed paper. For furniture, naphtha, and for carpets, steam will be found efficacious.

So far as the fly is concerned, a careful screening of the house and occasionally a few minutes of "skilled labor" in destroying any that have gained entrance, will be all that is necessary. Eternal vigilance is the price of immunity from this pest, but the destruction of all kinds of waste about the house will be found to be quite an assistance. The fly develops from a small, footless grub which feeds on decaying organic matter. In a few days it reaches its full size, forms a brown pupa, from which the mature fly emerges in a few more days and immediately deposits eggs for the production of a new brood.

The occurrence of fleas as pests in houses which are otherwise clean makes it desirable to know some remedy for them. They are usually brought into the house by dogs or cats. One way to get rid of them is to shut up in the room a mixture of cyanide of potassium and acid. This generates prussic acid gas, which is death to all forms of organic life. This, however, in inexperienced hands is hardly to be recommended. Dalmatian powder causes the fleas some inquietude even if it does not kill them. In purchasing this, no old powder should be accepted. The volatile oil, which is the destructive agent, evaporates after a while, and a guarantee of the freshness of the product should be required.

Kerosene emulsion is very efficacious against fleas, and every housekeeper ought to know how to make it and keep it on hand for the destruction of certain kinds of insect pests. Kerosene emulsion is made by dissolving half a pound of hard soap in two quarts of hot water and adding to this, when the soap is thoroughly dissolved, one gallon of kerosene. In adding the kerosene it is necessary to agitate the mixture. This is a stock which should be diluted with ten parts of water when it is desired to use it. Fleas, the red spider, plant lice and other insects succumb to it. It kills by contact. Insects breathe through holes in their sides—spiracles—and the oily kerosene, spinning a film across these apertures, seals them hermetically, so that the animal dies of suffocation. For a dog or a cat, washing with kerosene emulsion will clear away the fleas, and at the same time the mixture is one that will not injure the animal if licked from the coat and swallowed.

The mosquito has been one of the greatest and the most hopeless of pests. It breeds in great numbers in stagnant pools and standing water, beginning life as a "wriggler" in this water and subsisting on the decayed animal matter in the water or at the bottom. The female mosquito deposits her eggs in boat-shaped masses, twenty or thirty eggs in a mass. These hatch and the wrigglers spend their lives for a time in the water forming a pupa, and from this the winged mosquito finally emerges. The transformation from wriggler to mosquito, which must be accomplished at the surface of the water, is the key to the situation. It has been found that by proper treatment of the breeding places the pest can be nearly exterminated for adjacent localities. The first thing necessary is to locate the pools in which the mosquitoes breed, and then to treat the surface of these with crude oil, one gallon of which will cover fifteen square rods. This prevents the females from depositing eggs and also stops the transformation of wrigglers to adult mosquitoes. The oil will remain as a continuous coating even after a heavy rain. During the past season, in one locality, the hotel keepers have expended some twenty-four thousand dollars toward the suppression of the mosquitoes by this method and have deemed the money well expended.

Mr. Kirkland discussed the anatomy of the wriggler and the adult mosquito, stating that no poison glands have as yet been discovered in the animal, that it is a puzzle why the bite should be so painful, and added a grain of comfort by assuring his audience that only half of the mosquitoes did bite—the females—the males keeping to the woods and away from houses.

In the concluding portion of his paper Mr. Kirkland noted the peculiarities of the roach and the plant insects, recommending in the former case the use of Dalmatian powder or sugar and plaster of Paris, dry, and in the latter the kerosene emulsion in which the plants, if small, should be dipped.—Boston Commonwealth.

[FROM KNOWLEDGE.]

ADHESIVE ORGANS IN ANIMALS.

By R. LYDEKKER, B.A.Cantab., F.R.S.

EITHER for the purpose of holding on to inanimate substances and thus securing protection from attack or safety from the buffetings of the waves, or by attaching themselves to the bodies of other creatures, and thus obtaining any ample supply of food without any exertions of their own, a considerable number of animals have developed suckers, or other adhesive organs, on some parts of their bodies or limbs, and as these sucking organs vary considerably in their specialization and plan of structure in different groups, their comparison forms an interesting subject of study. In addition to these sucking disks, which are purely for the purpose of adhesion, there are in certain animals, such as the lampreys and leeches, suckers formed by the mouth, thus enabling the fortunate owners of such organs not only to attach themselves, but likewise to procure their food by devouring the blood or flesh of the animal to which they are temporarily fastened.

Probably the simplest, although nevertheless a highly efficient type of sucker are those of the limpet, and of certain other mollusks found on some parts of our coasts and known as chitons. In these creatures the sucker is simply the soft under surface of the body—the so-called foot—which on being applied to any fairly smooth surface, and the center elevated by muscular action, at once forms a sucking organ without any special structural modification. And it is probable that in a considerable number of instances suckers have originated from a portion of the general surface of the body having been used in this manner, and finally developing structural modification. Suckers, as everybody knows, are very commonly present in insects, but are much more rare among the higher animals and mollusks, and it is therefore chiefly from the two latter groups that our examples of these peculiar structures will be drawn.

Among mammals, suctorial disks are a very unusual feature. It is true that there are so-called blood-sucking bats, but these merely abrade the skin with their sharp front teeth and swallow the blood as it flows from the wound, without having the mouth modified for sucking. It is, however, in the same group that the best developed suckers found in the whole mammalian class occur. These suckers take the form of perfect adhesive disks developed on the wings at the base of the claw, and also on the soles of the hind foot, the wing disks being very much larger than those on the hind foot. Curiously enough, these suckers occur only in two species of bats, one of which (Thyroptera) inhabits Brazil, and the other (Myxopoda) the island of Madagascar; the distribution of these two species being one out of several instances of a community between the faunas of Madagascar and South America. In the Brazilian species the clinging organs take the form of small, circular, stalked, hollow disks closely resembling in miniature those of cuttlefishes. On the other hand, in the Malagasy bat the wing organ is a large, sessile, horseshoe-like adhesive pad, covering the whole of the lower surface of the thumb, and having its circular margin directed forward. In both cases the sucker on the hind foot is a miniature of that on the wing. By the aid of their adhesive organs these bats are enabled to cling to perfectly smooth vertical surfaces, in the same manner as a fly hangs on to a window pane.

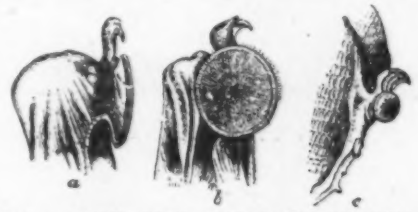


FIG. 1.—ADHESIVE DISKS OF SUCKER-FOOTED BAT.

a, b, disk of wing; c, that of hind foot.

Apparently the only other mammal furnished with suckers is a peculiar kind of web-footed water shrew (Nectogale elegans) from Tibet, in which the soles of the feet bear disk-like adhesive pads, by means of which the creature is believed to hold on to smooth rocks and stones in the beds of the rapid streams it frequents.

Among reptiles, many of the lizards belonging to the family of geckos have the extremities of their toes dilated into adhesive pads, by which they are enabled to cling to the surface of walls or upright faces of rocks. These do not, however, take the form of true suckers, but are marked by a number of very fine plates, or lamellæ, placed symmetrically to one another, but differing very markedly in their mode of arrangement in the various genera. This type of adhesive organ seems to foreshadow that of the remora among the fishes. In the amphibian class a different type of adhesive organ is displayed by many frogs, not only in the elegant little tree frogs (Hylidæ), but likewise in some of the true frogs (Ranidæ). In these animals the extremities of the toes are dilated into soft, rounded pads, furnished with a viscid secretion, while there are frequently similar pads on the under surface of the joints of the toes.

Although the sticky secretion doubtless plays an important part in rendering these disks adhesive, it is not improbable that they also act to a certain extent as true suckers.

Greater variety obtains in the adhesive organs of fishes. Perhaps the simplest type is that of the familiar little gobies (Gobiidæ) of our seaside rock pools, in which the pelvic or hinder pair of fins are united together in the middle line so as to form a circular, funnel-shaped cavity, apparently acting as an adhesive organ, by means of which these fish anchor themselves to rocks or sea weed. In the true gobies (Gobius) the disk thus formed is separate from the surface of the body, to which, however, it becomes attached in the members of the allied tropical genus Sicydium. Although formed in the same manner by the union of the pelvic fins to form its bony base, the adhesive organ of the much larger British fishes known as lump suckers (Cyclopterus) attains a considerably higher degree of development. Here it forms a circular disk placed close under the chin, and surrounded by a fringe of filaments; and so well does this sucker act that, when once attached, it is exceedingly difficult to make one of these fish let go its hold. In a fish of eleven and a half pounds, the disk measured upward of two and three-quarter inches in diameter, and Frank Buckland states that even after death its adhesive powers were retained; "for," he writes, "after casting the fish, and having cut out the sucker, leaving the thick side bones under the gills, as it were for handles, and having wetted the window sill, I placed the sucker flat on it, and it was just as much as I could do to pull it off vertically, but there was not the slightest resistance to any side movement."

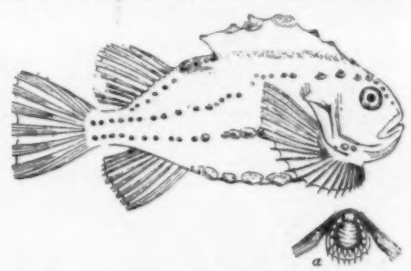


FIG. 2.—THE LUMP SUCKER AND ITS ADHESIVE DISK (a).

The most extraordinary adhesive organ is, however, that of the far-famed sucking fishes, or remoræ (Echeneis), of which there are about half a score species, some of which may attain a couple of feet in length. In these fishes the organ takes the form of a flat, oval disk, covering the upper surface of the head and neck, divided into a number of chambers by a middle longitudinal ridge, and a series of pairs of transverse partitions, varying in number from twelve to twenty-seven. The disk causes the upper portion of the head to be so flattened that, when the fish is placed in the ordinary position, it looks as though it were upside down; the illusion being intensified by the circumstance that generally the lower surface of the body is darker than the upper. Unlike what obtains in the fishes noticed above, in the remora the adhesive disk is formed out of the spinous or front portion of the back fin, which has completely lost its original character. Regarding its origin, Dr. Günther writes that the spines of the fin "being composed of two halves, each half is bent down toward the right and the left, forming a support to a double series of transverse lamellæ, rough on their edges, the whole disk being of an oval shape, and surrounded by a membranous fringe. Each pair of lamellæ is formed out of one spine, which, as usual, is supported at the base by an interneural spine." When the remora applies the disk to any flat surface, such as the skin of a shark, the shell of a turtle, or a ship's bottom, the plates, which are usually depressed, are raised, and a series of vacua produced, and by this means the creature adheres so tightly that it can scarcely be detached except by pushing or pulling it along the surface. Many fables have collected round the remora, which was known to Aristotle, and in Ovid's time it was believed to have the power of stopping a vessel on its course; although, how this was effected the poet is careful not to say. The dark coloration of the lower parts is due to the circumstance that, when attached to a foreign body, the fish generally have this surface turned upward. It has indeed been suggested that the fish habitually swims, even when detached, in the reversed position, but this has not been confirmed.

By being carried about, the remora, of course, gets a much better chance of obtaining food than would be the case if it had to depend upon its own powers of locomotion; but according to the observations of F. D.

Bennett, the duration of the fish's adherence to foreign bodies is much less than commonly supposed. Thus he writes that "it often merely swims round the body it attends, and only fixes upon it occasionally, and for a very short time. The adhesion of the buckler is chiefly effected by the smooth membrane that margins it. After the death of the fish, and even after the head has been separated from the body, the moist membranous border of this organ adheres to a plain surface with undiminished power. One muscle can be raised and depressed by the fish independently of the others, or all can be moved simultaneously and rapidly. Their uses are, to fix the sucker more firmly, to offer resistance in one determinate direction, and probably to liberate the sucker by relieving the vacuum."

Not the least curious feature connected with the remora is that it is a member of a family of which the other representatives have no adhesive disk; and it has a very near ally in a fish from the warmer coasts of the Atlantic and Indian Oceans, known as Elacate nigra. Hence the development of the suctorial disk is a peculiar and specialized feature which has not been inherited from other genera. That the evolution took place at an epoch comparatively remote is, however, proved by the occurrence of a fossil sucking fish in the lower Eocene slate of Glarus, in Switzerland.

To find an adhesive organ comparable to that of the sucker-footed bats, we have to go to the mollusks, where the cuttlefish and squids have these organs developed in great numbers on the tentacles, or so-called arms, surrounding the head. In most cases these are arranged on the non-pedunculate arms in rows (usually four or two), becoming smaller and more numerous

FIG. 3.—SUCKER OF CUTTLEFISH.

toward the tip of the arms; and whereas in some forms their base is flush with the surface of the latter, in others they are raised on short stalks. Then again, their margins may be strengthened by a horny rim, either smooth or crenulated; and sometimes their center is armed with a strong hook, which can be protruded or retracted like the claw of a cat. Structurally, according to the description of Owen, these disks have a slightly swollen margin, from which a series of muscular folds converge toward the center, where a circular aperture conducts to a cavity of gradually increasing width. Within this chamber is a kind of button, which can be elevated or depressed in the same manner as the piston of a syringe, so that when the sucker is applied and the piston withdrawn, a vacuum is immediately created.

It would be very interesting if we could trace the gradual evolution of these highly specialized organs, but this is unfortunately impossible. They may, however, have arisen after cuttlefish were evolved as a distinct group, since they are unknown in the allied group of cephalopods to which the nautilus belongs; but they are now constant throughout the group, and thus differ markedly from all the sucking organs hitherto mentioned. In the gigantic cuttles occasionally met with in the ocean, they attain an enormous size, being, it is said, in some cases, of the size of dinner plates. While these suckers are employed to anchor their owners to submarine rocks, they are likewise used for the purpose of seizing prey and bringing it within reach of the jaws, and in this latter respect differ from all those hitherto noticed.

Among insects, as already mentioned, many exquisite examples of adhesive organs are to be met with, but the only ones we have space to refer to here are those on the fore legs of the males of many of the water beetles of the family Dyticidæ. In the common English Dyticus the first joints of the tarsus are widely expanded so as to form a nearly circular plate; this being provided with a number of suckers, one of which forms a very large disk, furnished with strong radiating fiber, while a second and smaller one is of the same type. Besides these are a number of small tubular and somewhat club-shaped bodies, each furnished with a very delicate sucker at its extremity.

We have been unable to come across any account of the use to which these very beautiful examples of adhesive organs are applied, but their occurrence in the male sex alone may suggest one to our readers.

In all the foregoing instances the adhesive organs are formed either on the body or limbs, and, with the exception of the cuttles, are used solely as a means of attachment. The lampreys (Petromyzidæ) and leeches

FIG. 4.—SUCKING MOUTH OF LAMPREY.

(Hirudinidæ), which will be our last examples of these curious structures, afford, on the other hand, instances where the mouth is modified into an adhesive organ. In the lampreys, which, although formerly included among fishes, are now generally regarded as constituting a class by themselves, the mouth is surrounded by a continuous circular or suboval sucking lip, while internally it is armed with a variable number of sharp teeth resting on a soft cushion. Lampreys feed on the flesh of fishes, to whose bodies they attach themselves by means of the suctorial mouth, and when thus firmly fixed, rasp away the flesh with their teeth. Frequently they cling for a long time to the surface of their victims, and are thus carried long distances.

The occurrence of fossil lampreys in the older Paleozoic rocks of Scotland proves that this type of sucking mouth is at least a very ancient, and probably a primitive one.

Most likely the same is the case with the leeches, which, as our readers are doubtless aware, belong to the great group of annelids, or worms. In these, the anterior end of the body terminates in a large circular sucker, within which, or the pharynx, is the mouth. Very generally, as in the common medicinal leech, the mouth is armed with sharp teeth, and thus presents a curious structural similarity to that of the lampreys, although there is, of course, no genetic connection between the two groups. Many leeches also have a sucker at the opposite extremity of the body, by which they are in the habit of attaching themselves to the leaves of trees, from which basis they extend their bodies in the hope of catching hold of a passing animal. In their habits leeches also present a curious similarity to lampreys, except that they only suck the blood of their victims instead of feeding on the flesh.

Did space permit, many more examples of adhesive organs might be noticed, although the majority of the most striking have been referred to. While adhesive mouths appear to be primitive features of the groups in which they occur, other sucking organs, with the probable exception of those of the cuttlefishes, seem to be comparatively late developments, and occur only among certain members of the groups in which they are found at all. All these appear to have been produced quite independently in the various groups, and as a sucker is not capable of indefinite variation in form, it is not to be wondered at that structure found in one group is frequently paralleled in a totally different group. We have, therefore, in these organs another excellent example of that parallelism in development to which reference has been so often made in former articles in Knowledge.

NOTE.—Fig. 1 is taken from the "Study of Mammals," by Sir William Flower and R. Lydekker, and Figs. 2 and 4 from the "Study of Fishes," by Dr. Gunther, by courtesy of Messrs. Black. Fig. 3 is taken from Cooke's "Mollusks," by courtesy of Messrs. Macmillan.

[Continued from SUPPLEMENT, No. 1040, page 16629.]

COMMERCIAL FIBERS.*

By D. MORRIS, C.M.G., M.A., D.Sc., F.L.S., Assistant Director of the Royal Gardens, Kew.

LECTURE I.—(Continued.)

BOTANICAL INVESTIGATION.

THE distribution of the fiber bundles in the plant itself having been ascertained, the next point is to extract the fiber by mechanical or chemical means, and have it carefully washed and dried. A fiber thus extracted would consist of numerous threads, each of which would represent a fiber bundle or filament, and form the unit for spinning purposes. The general appearance of the fiber in this state, the softness and fineness of the filaments, their strength, color, and luster, are at once appreciated. If the fiber is entirely new, the further examination necessary would be under the microscope. It would be useful, for this purpose, to have both a dissecting microscope, with a lens magnifying 10 to 15 diameters, and a compound microscope, with lenses magnifying up to 300 diameters. The eyepiece of the latter should be fitted with a micrometer. The reagents necessary would be a solution of iodine, sulphuric acid, glycerine, carbonate of soda, and caustic potash. The first point is to determine the number of fiber cells to each bundle and the nature of the surrounding tissue. In some few cases the cells may be single, or in groups of two or three; in others, they may be in bundles of 30 to 50, more or less agglutinated together. A cross section would also show the size or shape of the cavity of each cell, the thickness of the cell wall, and the characteristic markings—such as concentric rings, if any—present. Each cell should now be carefully isolated. Its length, as already mentioned, is of great importance. The operation of measuring should therefore be repeated, according to the degree of approximation required. The extreme, as well as the average length, should be duly noted. The diameter of the cell is of less importance, but is also necessary.

CHEMICAL INVESTIGATION.

The aim of a chemical investigation of fibers should be to determine the quantity and quality of the cellulose and its chemical characteristics. These are of primary importance. Other points are subsequently investigated, and on the total results thus obtained are based the appreciation of the fiber and its possibilities as an article of commerce.

The points to be dealt with are as follows:

1. Moisture.—This is the water of condition or the hygroscopic moisture taken up by a fiber after being dried at a temperature of 110°. Textile fibers of the highest class are distinguished by their relatively low moisture. It might be mentioned that dry wood pulp in commerce contains, in an ordinary atmosphere, 10 per cent. of hygroscopic moisture.

2. Mineral Constituent.—This is the percentage of ash left after burning the fiber. The lower the percentage, the purer the cellulose.

3. Hydrolysis.—This is a bleaching process, in which one portion of the fiber (a) is boiled in an alkaline solution for five minutes. The loss of weight shows the proportion of the fiber which yields to the solvent action of the alkali. Another portion of the fiber (b) is boiled for one hour. The loss of weight in the latter case gives the "degrading" action of the alkali.

4. Cellulose.—A specimen of fiber having been boiled in dilute alkali, as indicated above, is well washed, and exposed for an hour, at the ordinary temperature, to an atmosphere of chlorine gas. "It is then removed, washed, and treated with a solution of sodium sulphite, which is slowly raised to the boil. After two or three minutes' boiling, it is washed, dried, and weighed." The percentage yield of cellulose, on the raw fiber, thus obtained, is the most important criterion of its composition and value.

5. Mercerizing.—This shows the action of concentrated solutions of alkalies upon vegetable fibers. This was first studied by Mercer, hence known under his name. The action is noted in regard to the loss of weight sustained.

6. Nitration.—Fibers exposed to the influence of a nitrating acid (a mixture of equal volumes of concentrated nitric and sulphuric acids) increase in weight. They also acquire various colors. The net increases in weight varies from 5 to 55 per cent.

7. Carbon Percentages.—Accepting cotton as typical cellulose, the amount of carbon obtained by ignition is 44·4 per cent. The lower carbon percentages are from 40 to 43; the higher, 45 to 50.

8 Acid Purification.—To clean the fiber, and remove all accidental impurities, it is heated to boiling point in a 20 per cent. solution of acetic acid. It is then dried and weighed. The loss in weight sustained shows the impurities present.

* Lectures before the Society of Arts, London, March, 1895.—From the Journal of the Society.

I.—SEED HAIRS.

From the morphological point of view the fibers of commerce may be either seed hairs, the bast fibers from the inner bark of Dicotyledons or the fibro-vascular bundles from the stems, petioles, or leaves of Monocotyledons. On the other hand, there is also a commercial classification. In this the various fibers are grouped as follows: (1) the higher textiles, such as cotton, flax, common hemp, Sunn hemp, and China grass; (2) the lower textiles, such as jute, Abutilon hemp, and Deccan hemp; (3) white rope fibers, such as Manila hemp, Sisal hemp, Mauritius hemp, and New Zealand Phormium; (4) brush and mat fibers, such as coir, piassava, kittool, and other palm fibers; (5) paper materials, such as esparto and wood pulp.

In the present lecture we shall confine our attention to the fibers of the Dicotyledons, embracing what are known as the higher and lower textiles, composed of (1) Seed hairs, and (2) Bast fibers from the cortical layers of the green stems.

COTTON.

The chief, and indeed the only commercial fiber from seed hairs, used in this country, is cotton. This consists of the delicate, tubular, hair-like cells clothing the seeds. The commercial value depends on the length and tenacity of these hairs or "the staple." The plants yielding cotton are among the most important in the vegetable kingdom. The use of cotton dates from prehistoric times. Sanskrit records carry it back at least 2,000 years, while in Peruvian sepulchers cotton cloth and seeds have been found. The value of the cotton manufacture of the United Kingdom exceeds £130,000,000 sterling.

The cotton plant belongs to the mallow family. Three species are generally recognized.

1. The Tree Cotton (Gossypium arboreum).—A small tree or shrub with red flowers; not cultivated, usually, for cotton, but a variety is said to yield the "Nurma" cotton of India.

2. American Cotton (G. barbadense).—In this species the seeds are readily separable from the cotton or investing hairs. The produce is regarded as the most valuable of any, and is known as Barbados, Bourbon, Upland Georgia and other short-stapled cottons. A variety (G. maritimum) yields Sea Island cotton, also Egyptian cotton, and a form of the latter called Bahmia cotton. G. acuminata yields Peruvian or Brazilian cotton, sometimes called "kidney cotton," from the shape of the seeds. G. barbadense is the chief corton plant of many parts of Africa, and the much prized "Dharwar" cotton of India. Of the world's supply of cotton, the United States contribute about 56 per cent., though, according to official statistics published in America, it is estimated at not less than 70 per cent. The average number of acres under cultivation in cotton from 1880 to 1889 was 17,731,172; the average yield per acre was 168 pounds; while the average price per acre to the farmer was 8·8 cents. In the previous ten years, from 1870 to 1879, the average yield per acre was 191 pounds, while the average price to the farmer per acre was 12·8 cents. Hence it may be inferred that the productive power of the cotton lands in the Southern United States has declined of late years, as also the profit to the farmer.

3. Asiatic Cotton (G. herbaceum).—The cotton is not so readily separable from the seeds. This and its varieties and hybrids, too numerous to mention, yield the chield cottons of India, such as Surat, Madras and Bengal cottons. The plant is common in the Mediterranean region and every part of tropical Africa. It can be cultivated in colder countries than G. barbadense. A Chinese variety yields Nankin cotton, which is of a tawny color. The total area in cultivation under cotton in British India in 1892–93 was nearly 9,000,000 acres. The largest areas were in Madras, Berar, Bombay and the Northwest Provinces. The highest exports during the last five years took place in 1889–90, when cotton to the value of 187,000,000 rupees was shipped from India. The export in 1892–93 was slightly less, being of the value of 127,000,000 rupees. Besides cotton, there was exported from India cotton seed in 1888–89 to the value of 301,577 rupees; in 1892–93 this had fallen to a value of 61,708 rupees.

As regards the industrial application of the various kinds of cotton, the following is a brief summary:

Sea Island and Egyptian cottons are chiefly employed for fine muslins and laces; Braz lian and ordinary American, for cambrics and calicoes; inferior American and Indian, for fustian and heavy fabrics.

Further particulars of a useful character on cotton, its cultivation, production, distribution and consumption, may be obtained from the article, "Cotton," in Chambers' Encyclopedia, iii. pp. 507–516. The present year is remarkable for the unusually low prices obtained for all kinds of cotton. Good, fair Bengal was selling on the 25th March last at 2¼d. per pound, good ordinary American at 3⅞d. per pound, while even the best Egyptian realized only 5⅞d. per pound. As a result, many cotton-producing countries are reducing the area of cultivation and directing attention to other products.

KAPOK AND VEGETABLE SILKS.

Kapok is the Dutch name for the seed hairs of the white silk-cotton tree of the East Indies (Eriodendron anfractuosum). The kapok of Java is regarded as the best. It is, however, too short in the staple, too smooth and too soft to be spun into yarn. Its chief use is for stuffing pillows, mattresses and sofas, where its lightness, insusceptibility to moths, softness and elasticity render it superior to all but the best qualities of feathers, wool and hair.

The floss from the red silk-cotton tree, Bombax ma-

labaricum, known in India as Semal, is regarded as inferior to that obtained from the white silk-cotton tree. The principal market for kapok is Holland. In 1885 Java exported 600,269 kilos of kapok. In the West Indies both Eriodendron anfractuosum and Bombax ceiba are known as silk-cotton trees. It was recommended by the writer, in 1884, to export silk-cotton from Jamaica, where, at a low estimate, about 3,000 bales could be gathered every year.

The Down-tree (Ochroma lagopus) of tropical America, especially Jamaica, belongs to the same natural order as the silk-cotton trees. The pod is long, and channeled longitudinally. The silken down which envelops the seeds is of a rich fawn color and very soft and elastic. It is used, locally, for stuffing beds. As the tree grows very fast, the down might be readily produced in large quantities. Macfadyen says, "there is no doubt it could be made into cloth and employed in hat making."

The silky cotton of Cochlospermum Gossypium, sometimes known in India as the white silk cotton tree, but entirely distinct from the tree above described under that name, has hitherto received little or no attention. The tree is common in the lower hills of India and is often planted near temples. It has large, handsome, yellow flowers, and its pendulous, pear-shaped fruits ripen before the new leaves appear. The cotton is soft and silky, but very short. According to Dr. Watt it could be supplied at a much lower rate than the kapok and has a resistance about it which prevents it from matting, like semal, when used in upholstery. This fiber has not yet been placed within reach of the European manufacturer. Its value is practically unknown.

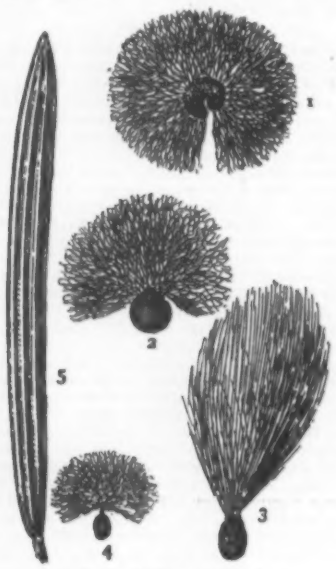


FIG. 2.—SEED HAIRS.

1. Cochlospermum Gossypium. 2. Kapok (Eriodendron anfractuosum. 3. Madar (Calotropis gigantea). 4. Down tree (Ochroma lagopus). 5. Fruit of do. (reduced).

Vegetable Silks.—Many plants belonging to different natural orders yield silky hairs, usually straight, forming a coma or tuft at the apex of the seeds. Few of these have hitherto been investigated. The most familiar is that of the "madar" or "yercum" (Calotropis gigantea), or of the closely allied species (C. procera). The natives of India "regard the madar silk hairs as much cooler than semal, or red silk-cotton, and affirm that they have a soothing effect when used in pillows." As the plant will thrive in waste and almost sterile and dry tracts of India, it would not be difficult to produce the silk hairs in any quantity. So far, however, it is nowhere cultivated. It is widely distributed in both the old and new world tropics. In the West Indies it is known as French cotton, and the floss is used for making fans. Dr. Watt states that owing to the attention drawn to this fiber at the Colonial and Indian Exhibition, 1886, "it has been found possible to utilize it by mechanically drawing it in with cotton in the preparation of fans." To overcome the difficulty of procuring a uniform supply, it was proposed to attempt to cultivate the plant on a large scale. "It may thus be hoped that madar fiber may at last be viewed as an established new industry that will greatly benefit the poor cultivators of a large tract of the less productive portions of India."

A noted vegetable silk is yielded by Beaumontia grandiflora, an extensive climber in East and North Bengal, with large showy flowers. It is cultivated in gardens for ornament. The seed hairs are said to be the best yet known, though least utilized. Specimens are in the Kew Museum. The fiber is very lustrous and purely white. It also possesses a remarkable degree of strength. The hairs are easily separated from the seeds, and are usually more than an inch and a half long.

In the Argentine the silky hairs obtained from a plant known locally as the "yachan" (Chorisia insignis) are used for a singular purpose by the Mataco Indians. These people make a netted cuirass from the fiber of a wild pineapple (Bromelia serra). This is padded before and behind with the silk hairs of the yachan. In order to make it impervious to the arrows of their enemies, the Indians roll themselves in water, until the fiber swells into a felted mass. The singular property possessed by this fiber could no doubt be utilized for other purposes.

II.—BAST FIBERS.

The most familiar of bast fibers is the coarse reticulated bast of the lime tree, used for making Archangel mats. This is obtained from the inner bark. In other plants, such as flax and China grass, similar bast fiber is capable (as will be shown later) of being divided into fine, silky filaments, with strength, flexibility and luster almost equaling the finest silk.

The various bast fibers here enumerated are arranged in accordance with what is believed to be their intrinsic value.

FLAX.

Flax, commercially, is the most important textile fiber next to cotton. It has been cultivated from remote antiquity. The plant (Linum usitatissimum) is an annual. The area of cultivation is world wide, but chiefly in the temperate zone. The most suitable localities are belts of coast land, subject to the moisture laden winds from the sea. The value of the flax and tow imported into the United Kingdom, in 1893, was £1,104,851 sterling, chiefly from Russia. The other flax-producing countries are Germany, Austria, Italy, France and Belgium. The Belgian flax is unequaled for quality. In the United Kingdom there are only 10,000 acres under flax. Large areas are cultivated in the United States, Canada and Briti h India, but almost entirely for seed purposes. Over 2,000,000 quarters of seed for oil and oil cake purposes are annually imported into this country. A white linseed, in India, yields 45 per cent. of oil of a very light color. The fiber of flax is extracted solely by retting the stems with dew or in water. Then follow the "breaking" and "scutching," which consist in beating and shaking the broken flax in order to free it from loose and useless particles. All these are usually undertaken by the cultivator.

It is generally admitted that a new source of supply for flax, or at least a good substitute for it, is a desideratum in English manufacture. This may lead, eventually, to the commercial utilization of China grass or ramie.

Good flax fiber consists of 80 per cent. of cellulose. The ultimate cells are 25–40 mm. long (about 1¼ to 2 inches). In these two important characteristics, flax is practically at the head of commercial fibers.

Remarks.—The bast layer in flax is in a continuous ring; sometimes two concentric fibrous zones are developed; the fibers with different features in each. The fiber bundles contain 5 to 10 cells or filaments, which are easily subdivided. The cells, as already stated, are 25–40 mm. long. The normal have a small diameter, are thick walled and polygonal. The others are ovoid, with a large cavity resembling ramie.*

HEMP.

The term hemp is often used in a generic sense, and is applied to fibers derived from entirely different plants. Sunn hemp is yielded by a species of Crotalaria, Manila hemp by a wild plantain, Sisal hemp by an aloe (Agave), while "Chinese hemp" is applied indiscriminately to the fiber of an Abutilon, pineapple, China grass, as well as to the common hemp. The latter is the fiber of an annual (Cannabis sativa) closely allied to the hop plant. Hemp is largely cultivated in Central and South Russia, Hungary, Germany, France and Italy. Italian hemp is regarded as the best. In India, hemp is cultivated solely for the narcotic resin yielded by the leaves and flowers. The dried leaves are known as "bang," while the dried flowers are called "gunjah." Both of these, as well as the gum resin itself, are used for smoking. The characters of Indian hemp fiber, explanatory of the fact that it is useless for commercial purposes, are fully discussed by Vétillart, pp. 72–75. In temperate countries the fiber yielded by the male hemp plants is tougher and better than from the female plants. The male plants are gathered first, while the female plants are collected a month later. The extraction of hemp fiber is effected by means of retting, and breaking, and scutching, as in flax. Hemp ropes are very durable, and possess great strength and elasticity. In the Kew Museum is a portion of the cable of the Royal George, sunk at Spithead in 1782, and samples of paper made from it. Owing to the number of fibers, not real hemp, mixed together in the customs' returns, it is impossible to give those for common hemp alone.

MADAR FIBER.

Madar (Calotropis gigantea), already mentioned as yielding silky seed hairs, also yields, from the inner bark of the young shoots and branches, a very valuable fiber. Dr. Watt speaks of it as one of the strongest and finest of vegetable fibers, and one of the most beautiful. By nitrating the fiber, under chemical treatment, a substance was produced by Cross and Bevan which could be scarcely distinguished from silk.

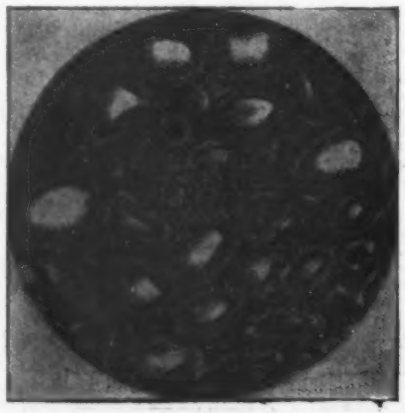


FIG. 3.—MADAR (CALOTROPIS GIGANTEA).†

Section through a portion of the bast region. The fiber cells are oval, with thick walls, loosely cohering together, and possessing characteristic markings. × 300.

The high expectations raised in regard to this fiber have not, so far, been realized; but, as the plant will grow in the poorest soils, and requires little cultivation, its double products of bast fiber and floss deserve the fullest investigation.

Remarks.—In the plant the fiber bundles are disposed in aggregates of 50 to 100. The cells are oval, loosely coherent. The bundles are usually in short lengths, 8–16 inches, owing to the nodes of the stem. The filaments, or cells, are 10 to 30 mm. long, ends tapering.

RAJMAHAL HEMP.

A large twining shrub (Marsdenia tenacissima), found in Northern India, is remarkable as yielding "one of the strongest and best fibers known in India." It is next to ramie in point of fineness and durability. If this plant could be cultivated for its fiber, it would become most valuable. Little, however, has been done in this direction since the days of Roxburgh. In point of intrinsic merit, Rajmahal hemp stands in the first rank of textile fibers. It is, however, quite unknown in commerce. Its merits are well set forth in Watt's "Dictionary of the Economic Products of India," V. pp. 188–190.

Remarks.—The fiber bundles are 10 to 15 inches long, with 10 to 30 cells in the bundle. The cells are 5 to 20 mm. in length.

(To be continued.)

* Unless otherwise stated, the information in this and subsequent remarks is based on "Indian Fibers," by Messrs. Cross and Bevan.

† This, and similar illustrations, are from photo-micrographs by Mr. John Christie, F.R.M.S., of 72 Mark Lane, E. C. Both Mr. Christie's intimate knowledge of commercial fibers and his large and varied collection of preparations relating to them have been very generously contributed to enhance the value of these lectures.

[FROM THE GARDENERS' MAGAZINE.]

LECTURE ON POTATOES.

At the afternoon meeting of the Royal Horticultural Society, recently, Mr. Arthur W. Sutton, F.L.S., gave a highly interesting lecture on "Potatoes," to which, as so well known, he has devoted a large share of his attention for many years past. The lecture was illustrated by means of admirably executed lantern slides, mostly reproductions of photographs taken in the trial grounds of Messrs. Sutton & Sons, at Reading, and was so much appreciated by the audience that we give it practically verbatim, with illustrations of some of the most interesting slides. After the routine business had been disposed of, and a few introductory remarks made by the chairman,

Mr. Sutton, in his opening remarks, said that when he was asked to read a paper before the Royal Horticultural Society on "Potatoes," the much esteemed secretary was kind enough to say that the council purposely wished to leave the title somewhat vague, so that he might feel at liberty to take up whatever branch of the subject he might prefer. Naturally, he appreciated the confidence thus shown, but in some respects it made his position more difficult, as the subject of potatoes, while not in itself perhaps particularly attractive even to the majority of horticulturists, is yet so comprehensive and inexhaustible that one scarcely knows where to commence. It might have seemed easier had he been asked to deal with any one of the many aspects of the question which the consideration of the potato would naturally suggest, but, had this been the case, he would have felt he was only following where others had already said all that could be said, and, perhaps, it was from a knowledge that every point had been so fully dealt with that Mr. Wilks thought it best to leave to the speaker the task of finding something new to say where everything interesting has already been said. But, he observed, what are the actual facts of the case?

ORIGIN AND INTRODUCTION.

If he took the origin of the potato and its introduction into England, everything had already been written that could be desired, but the following extract from Loudon's "Encyclopædia of Gardening," published in 1836, was, he considered, of sufficient importance and interest to be included in the lecture:

"It appears probable that the potato was first brought into Europe from the mountainous parts of South America in the neighborhood of Quito, where they were called papas, to Spain, early in the sixteenth century. From Spain, where they were called battatas, they found their way to Italy, and there received the same name as the truffle, taratoufli. From Italy they went to Vienna, through the governor of Mons, in Hainhault, who sent some to Clusius in 1598. To England the potato found its way from North America, being brought from Virginia by the colonists sent out by Sir Walter Raleigh in 1584, and who returned in July, 1586, and, 'probably,' said Sir Joseph Banks, 'brought with them the potato.' Gerarde, in his 'Herbal,' published in 1597, gives a figure of the potato under the name of potato of Virginia, whence he says he received the roots; and this appellation it appears to have retained in order to distinguish it from the battatas or sweet potato (Convulvulus battatas), till the year 1640, if not longer. Gough says the potato was first planted by Sir Walter Raleigh on his estate of Youghal, near Cork, and that they were soon after carried into Lancashire. Gerarde and Parkinson, however, mention them as delicacies for the confectioner and not as common food. Even so late as Bradley's time (1716), in his 'Historia Plantarum Succulentarum,' they are spoken of as inferior to skirret and radishes."

Monsieur Henri L. de Vilmorin, in his lecture on the best kinds of potato, read before the Agricultural Society of Paris, on January 20, 1888, mentions, Mr. Sutton pointed out, that toward the end of the sixteenth century the potato was introduced directly into England, where it rapidly obtained a position among the common vegetables of the garden. On the Continent, however, its progress was attended with greater difficulty. The prejudices which existed against its general use were, however, combated with energy by certain men devoted to the public welfare, such as Duhamel du Monceau, Inspector-General of Naval Construction, Mgr. du Barral, Bishop of Castres, and the Minister Turgot himself. It was reserved, however, to Monsieur Parmentier to succeed where so many devoted men had failed, and his success was due, above all things, to his perseverance and the tact with which he profited from his intimate knowledge of the character of the Parisians. Instead of trying to convince them by argument, he undertook, with the consent of the king, Louis XVI, to plant potatoes on the plain of Les Sablons, and, surrounding his experiments with a certain air of mystery, he undertook to guard the plot by a cordon of troops, and succeeded thus in adding to the curiosity of the popu-

lation. Then, when he had invited a certain number of scientific and influential men to a banquet where every dish was either composed chiefly of potatoes or was served up with potatoes as an accompaniment, he provided the most eloquent demonstration possible of the culinary properties of the new vegetable. His cause was gained. During the end of the eighteenth and the early years of the nineteenth century the potato made great progress, and when, in 1813, the Central Society of Agriculture undertook to provide, as a basis for study of the culture of the potato, a collection of the varieties then in use throughout the French empire, it brought together no less than 115 to 120 varieties. Count Rumford, in the middle of the last century, painfully tells of the trouble he had to persuade the people of Munich to use the potato as food, even in a time of great scarcity; in fact, only by disguising the potato in a kind of soup did they gratefully accept his offering.

Then, if he were to discuss the various species of tuber-bearing solanums, had not Mr. Baker, in his very able paper read before the Linnæan Society in January, 1884, entitled "A Review of the Tuber-Bearing Species of Solanums," given the result of such careful research that none but the most rash would attempt to follow him in the same field of inquiry? Or, if one wished to trace the history of the potato and its susceptibility to disease, are we not met at once with the singularly complete and exhaustive paper contributed by Lord Catheart to the Journal of the Royal Agricultural Society, Part I, April, 1884?

Coming down to the practice of potato culture we have had treatises on various new or improved methods, such as the "Jensen" system of earthing up potatoes, the best time to plow and manure the land, the best kinds of land for potatoes, the best kinds of potatoes for the various descriptions of land, the best manures for any and all soils, the best methods of planting and lifting and storing the crops, and other topics too many even to mention, either one of which alone might afford material sufficient for an ordinary lecture.

Then there is the increasingly important question of disease prevention, which can be treated from at least two chief starting points, either with the object of simplifying and extending the French system of spraying the crops when growing with the Bordeaux mixture known as "Bouillie Bordelaise," or of dusting the plant with the same compound in the form of powder, and thereby saving from disease the sorts of potatoes already largely grown; or, on the other hand, of introducing varieties obtained by cross fertilization, which may have proved themselves able to withstand the ravages of the dreadful fungus.

On all these topics, except the last, so much has been said already that Mr. Sutton stated he could not hope to interest his audience with any additional remarks of his own, but having long been identified with the raising and introduction of seedling potatoes, he thought it possible that he might succeed in popularizing this branch of study, especially if aided by the lantern views which Messrs. Newton had made for him from photographs taken specially for this lecture.

It had already been said that the potato was introduced into Europe early in the sixteenth century, and into England about the year 1586. He wished he could throw upon the screen a picture of what the potato was like as first grown by Sir W. Raleigh and others, but photography was not then known, and he had not met with any authentic engraving of that time.

The first picture on the screen gave the portrait of Gerarde, which appeared in the frontispiece of Johnson's edition of his well-known "Herbal," and Gerarde

POTATO PLANT (after Gerarde).

has in his hand a spray of the potato plant with flowers and berries, Johnson evidently thinking the potato plant one of the most important and valuable of those so ably described in the "Herbal." The next two slides represented the engravings of the potato plant on page 927 of Johnson's edition of Gerarde's "Herbal." Gerarde's somewhat quaint description of the plant and its uses after the lapse of three hundred years was read by Mr. Sutton.

This picture suggested many thoughts and comparisons, for how little like the fine, handsome, and even tubers we see at this time for sale at all the greengrocers in London and elsewhere were those represented! Then, also, the use of the potato in Gerarde's time by the wealthy few as a luxury of questionable value or utility, how different to the present enormous consumption in all civilized parts of the world!

ACREAGE IN THE UNITED KINGDOM, FRANCE, AND GERMANY.

While Gerarde's potato was before the audience it would be interesting to note that the acreage planted in the United Kingdom in 1894 amounted to 1,282,055 acres, averaging 3 tons 15 cwt. 2 qrs. 20 lb. per acre, or a total of 4,662,147 tons grown in the United Kingdom, besides a large quantity imported (for 1893 the figures were 14,140 tons). Reckoning the entire population as

POTATO ROOT (after Gerarde).

37,880,764, this would allow about 2 cwt. 1 qr. 24 lb. for every man, woman, and child per annum, but these figures make no allowance for the quantity annually consumed in feeding cattle, which is always considerable and varies chiefly in proportion to the market value of potatoes.

His friend, Monsieur H. de Vilmorin, had very kindly sent him the figures for France, and those show that the acreage under cultivation is annually about 3,342,500, and the total yield for the whole of France is 10,100,000 tons, or, making allowance for the quantity exported and imported, the figures stand at 10,000,000 tons. While in England potatoes are grown almost entirely for use as a vegetable, Monsieur Vilmorin estimates that about two-fifths, or 4,000,000 tons, are annually used in France in the manufacture of starch and alcohol. The lecturer had also learned from his friend, Herr Fritz Benary, of Erfurt, who forwarded him valuable statistics, that the total acreage devoted to potatoes in the German Empire in 1893 was 7,592 165 acres, and the total quantity of potatoes harvested amounted to 32,277,851 tons, or allowing for the quantities imported and exported, 32,376,497 tons, which was the total quantity available. Out of this total 6,074,732 tons were used for seed purposes to plant the crops of the following year, leaving 26,301,765 tons for consumption. Of this enormous quantity, 26,301,765 tons, Herr Benary says that 1,313,584 tons were used for distilling purposes, but he was unable to say how much of the remaining 24,988,180 tons were used as a vegetable and how much in the manufacture of starch, as no statistics are available. From the figures quoted some idea was obtained of the enormous commercial and economical advantages which have resulted from the scientific researches of those who first discovered and introduced the potato into Europe. How marvelously has the potato grown in popularity since Gerarde's day!

IMPROVEMENT OF THE POTATO.

It would be interesting to trace the steps by which the great improvement in the cultivated forms of the potato has been brought about. Fortunately, in this instance, it cannot be said the old rule that "like produces like" holds good, for had the development of the potato been restricted by such limitations, it is probable that our present supply of potatoes would be similar to those of which Gerarde speaks. And here it is necessary to refer to a misunderstanding arising from the fact that "seed potatoes" and "potato seed" are often supposed to be one and the same thing. Seed potatoes may be either a crop of potatoes grown with the special object of producing tubers to plant again the following year, or else, as is frequently the case, they are merely the smaller tubers, which, being too small for market, are, therefore, kept back for planting. Now it is well known that potatoes are merely the enlargement of underground stems, shortened and thickened, in which starch is stored up in greater or less proportion according to the several varieties. Like other stems, the tubers produce buds or eyes and are capable of reproduction by fresh shoots at the axil of the leaves, which in the case of underground stems are replaced by simple scales scarcely visible.

Although they may be kept through the winter and planted again the next spring, they are in no respect anything more or less than portions of the old plant which had died down and apparently ceased to exist the previous autumn. Consequently, while through the almost unlimited prolongation of the life of a single potato plant weakness and deterioration often set in, there is practically no room for improving the original type by any selection of tubers. This anyone can prove by planting a tuber which may from some cause or other be misshapen, and the produce will be found to revert to the same handsome and uniform type as the other potatoes which are growing on the same plant. The only modification of this rule is in the cases where all the tubers of one plant show a uniform divergence in character, either for better or worse. When this is so, it is possible that by the selection of all or any of these tubers a slightly different potato might result, as in the case of some types of the Ashleaf section, which are dwarfer and more compact, or else taller and coarser growing than others. Outside the Ashleaf class, however, no such instances are known. In reference to this point, Monsieur Vilmorin mentions he does not consider a really first-class seedling potato is liable to degenerate so quickly as is generally supposed. If degeneration sets in soon after its introduction, it merely proves that the variety is one which never ought to have been brought to public notice.

Potato seed, on the other hand, is totally distinct in every way, being the seeds formed in the potato berries which some, though not all, varieties of potatoes bear so freely. Before, however, describing the berries and the seeds they contain, a picture of the well known potato flower was shown. In the three following slides some of the berries in the natural condition, and also cut to show the arrangement of the seeds within the berries, were thrown upon the screen. A berry may contain from one hundred to three hundred seeds—the average of five berries examined being two hundred and thirty-two!—and as the parent plant appears able to control but slightly the distinctive character of its progeny, and as all the different seedlings from one potato berry may produce plants differing from one another, not only in form but many of them in color also, it is here we find the great possibilities for improving the race by selection of the better seedlings. Even if no cross fertilization of flowers were attempted, great improvement might be made by the selection of the most promising seedlings during the first few years of their existence, but where judicious crossing of the best known varieties is undertaken we can in a great measure combine in some of the resulting seedlings the merits of both male and female parent, although, even then, no two seedlings from the same berry may be exactly alike.

Anyone attempting to raise seedling potatoes must have abundance of patience. Like many other species which are not habitually multiplied by the seed, the potato has a remarkable tendency to revert to the wild form. It may be necessary to cultivate one hundred or even one thousand seedlings before finding one which is really worthy of a place among the better varieties already existing. Monsieur Vilmorin says that in France the raising of seed potatoes has been proceeded with in a somewhat haphazard manner, whereas in England, on the other hand, a more systematic method has been followed, mentioning that richness in starch, excellence of flavor, power of resisting disease, with little tendency to develop haulm, are the characters we generally seek. Unfortunately, he says, they are not always able to profit in France by progress realized in England, because the French have a marked preference for potatoes with yellow flesh, whereas in England, for many years past, there has been a preference for white fleshed potatoes. On this account even the celebrated Magnum Bonum, which Messrs. Sutton and Sons introduced in 1876, after having enjoyed a brief popularity in the Paris markets, has been almost abandoned as a table variety on account of the flesh being too pale in color. Monsieur Vilmorin remarks that in Germany considerable attention has been given to raising seed potatoes, but more particularly with the object of raising varieties which are specially adapted for the production of alcohol and starch.

The next picture showed the potato flower with the stamens removed, leaving only the pistil. In all artificial crossing it is necessary to remove the anthers at a very early stage to prevent the pistil being pollinated from its own anthers, slides illustrating the arrangement of anthers around the stigmas, both closed and expanded, and the inner surface of

FLOWERS OF THE POTATO PLANT.

three anthers and their pollen were also shown. The next slide was from a photograph of a potato seedling at the end of the first year, or, perhaps, more correctly speaking, the second year. In this case the flower was fertilized in the summer of 1894 and the seed was sown in the spring of 1895. The photograph was taken in September last. The next picture showed a similar seedling in its fourth year, and indicated the gradual maturing of the tubers into a fixed and regular type. It was added that it is not until the fourth or fifth year that it is possible to say how far the character of the seedling is fixed or not.

(To be continued.)

LYCORIS AUREA.

SEVERAL plants of this excellent autumn flowering species were shown by Messrs. Wallace & Company, of Colchester, at the meeting of the R. H. S. on October 29. Lycoris is allied to Amaryllis, but is distinguished from that genus by the small number of ovules in each cell of the ovary. The length of the segments in Lycoris aurea is 3 inches, and the color a rich orange; the anthers are yellow colored. The flowers appear usually in August and September, and before the leaves: the plant is amenable to greenhouse culture. The bulb is sub-globose, 2 inches in diameter. It is figured in the Botanical Magazine, t. 400, as Amaryllis aurea, and it was introduced from China in 1777 by Dr. Fothergill.—The Gardeners' Chronicle.

THE PLANET JUPITER.

THIS bright planet now rises more than two hours and a half before midnight, and as his northern declination is about 18½°, he attains an altitude of about 57° when southing at about 5:15 A. M. His apparent equatorial diameter this evening (November 14) will be nearly 40·5", and is increasing daily, so that by the end of the year it will be 45·6", when the planet will be visible nearly all night, and remain above the horizon during a period of 15½ hours. He will arrive at opposition to the sun on January 24, 1896, and will then be displayed under the best conditions.

To those, however, who are disposed to study the complex and variable features exhibited by the belts, the present is an important time, for it is advisable that such markings should be watched during long periods, and that a large number of their transits should be recorded. Their individual rotation periods may then be ascertained, and the differences determined, together with the fluctuations of speed affecting the same objects. Details of this character can only be correctly derived when the observations are numerous and extend, at least, over a fairly long period of time. Materials of the kind alluded to, obtained in the early part of the opposition, are of special value for comparison with the observations made at the time of opposition, and with the terminal ones which may be secured in the evenings of June, 1896, just before the planet leaves us for a season.

The features of Jupiter, though liable to certain changes, are yet, in some of their leading characteristics, remarkably durable. Like the spots on the sun, many of the markings on the planet disappear and reappear under very similar aspects. In fact, we are not without evidence that a certain degree of periodicity regulates the visibility of certain spots on the disk. In 1870 there was an eruption of dark spots along a belt in about 25° north latitude. In 1880 the phenomena appear to have recurred, for the same belt became studded with black spots, and in 1891 similar appearances were repeated. These markings are remarkable, as possibly indicating a periodical recurrence at intervals of about ten or eleven years. But it may be gravely doubted whether, in the present state of our knowledge, the materials exist for suitably investigating the question as to cyclical changes in the Jovian spots. The individuality of observers must affect the matter to a considerable degree, as their drawings and descriptions of the same features are seldom in agreement.

In recent years, the great red spot has not been so much observed as formerly. It has lost its striking character and its novelty, and planetary students have somewhat neglected it for newer objects more readily within reach. During the last ten years the mean rotation period of the spot has been 9h. 55m. 41s.; but it has shown some irregular variations. The slackening motion of the spot which operated so perceptibly between 1879 and 1885, and added seven seconds to the rotation period, appears to have been checked in the latter year, and the rate has been pretty evenly maintained since that time.

As to the visible aspect of the spot, it is now extremely faint, and can only be discerned on a good night of definition. Its feeble outlines are generally lost amid the very dark and well marked boundaries of the belts in its immediate vicinity. But on a good night it is seen as a pinkish discoloration of the bright zone outlying the great southern equatorial belt, though its beautiful oval outline is distinguished with difficulty.

One of the interesting features of recent oppositions of Jupiter has been the series of dark and white spots plentifully arranged along the northern side of the great northern equatorial belt. These markings move swifter than the red spot, but not much so, for their period is 9h. 55 m. 35s., or only six seconds less. They show changes, for sometimes one may be seen exceedingly dark, if not absolutely black, and just like a satellite shadow in transit; but in a week or two a great decadence of tone may have affected it, and it appears scarcely darker than the belt on which it lies. These markings, so prominently fringing the northern belt, have certainly been visible during the last ten years. In 1885 I found their motion about 8 seconds swifter than that of the red spot, but there were irregularities. Different spots, though in the same longitude and, probably, of the same character, do not yield coincident times of rotation, nor does any one object maintain exactly the same rate during a long period of time. The current in which they are situated, and by which they are transported to different longitudes, evidently suffers inequalities of speed, which are probably due to local disturbances underlying it.

These features of the northern belt are still very pronounced. On the morning of September 27, I observed two very dark spots projecting north from the belt and preceding the red spot at intervals of about four and two hours. The red spot follows Mr. Marth's zero meridian (System II) by about seven minutes, but I have only obtained two observations since Jupiter has been visible as a morning star, and neither of these was very satisfactory.

During ensuing months it will be important to make as many drawings as possible and to secure a large number of transits of the various markings. Among others the following may be specially mentioned:

(1) Light and dark spots near the equator (period 9h. 50m. 6s. in 1880, increased to 9h. 50m. 30s. in 1888).

(2) Dark spots on a belt in latitude 25° + (period 9h. 48m. in 1880, increased to about 9h. 49½m. in 1891).

(3) Dark spots and breaks in a very narrow belt in latitude 35° + (period 9h. 55m. 39s. in 1895).

(4) Light and dark spots in the region south of the red spot (period 9h. 55m. 18s., and apparently unchangeable between 1880 and 1891).

In the course of his work, the observer will also detect other features worthy of attention.

From eye-estimated transits the periods of the various objects can be very accurately ascertained, and Mr. Marth's valuable ephemerides for physical observations of Jupiter, published in Monthly Notices (June and supplementary numbers, 1895), will assist the student to reduce his own materials.—W. F. Denning, in Nature.

LYCORIS AUREA—FLOWERS ORANGE.

GEOLOGICAL HISTORY OF LAKE GEORGE.

By Prof. G. FREDERICK WRIGHT.

THE generalization that lakes owe their existence either to glacial dams or to the irregularity of glacial deposits is so nearly correct that one can approach the solution of any particular problem respecting lake formation with great confidence. The exceptions are so few, and are due to causes which are so manifest upon the surface, that they occasion little uncertainty. The interest attending the solution of each problem is, however, unfailing, since here, as elsewhere, Nature never repeats herself, but presents endless variety in the midst of unity. The history and beauty of Lake George have given peculiar interest to recent investigations concerning its origin, while the success with which the problem has been solved adds an important confirmation to the glacial theory.

Lake George is 326 feet above the sea and 225 feet above Lake Champlain, with the upper end of which it is parallel through most of its course, and but a few miles distant from it. The descent to Lake Champlain is made over a succession of falls at Ticonderoga. The same generalization which attributes all lakes to glacial origin attributes waterfalls to the same cause, and sets the observer looking for a preglacial channel near by, which has been filled with glacial debris, so as to turn the water into a new course. The brevity of post-glacial time is such that in most cases the recession of the waterfalls has been slight as compared with the enormous erosion during the long ages of preglacial time.

A brief examination of the topography about Ticonderoga reveals the line of the preglacial channel, now filled with glacial debris, running west of the present course of the outlet. Not only is there here ample space for a buried channel, but through much of the way there is a marked depression near the mountains extending around to Lake Champlain half way between Ticonderoga and Crown Point. Indeed, this depression is one of the most striking features in the local topography, and in the northern part it is filled to a depth of one hundred feet or more with Champlain clay, whose character is clearly displayed in deeply eroded gorges worn out by the small streams. In the upper part of the depression the railroad leading from Fort Ticonderoga to Lake George comes down into the old channel, and near the Catholic cemetery recent floods in the small streams have exposed the glacial deposits down to the depth of the bottom of the upper falls.

At the south end of the lake there is a still more interesting condition of things, showing that to produce it there is required not only a dam at the north end, but a dam at both ends; so that if the dam at Ticonderoga had been twenty-five or fifty feet higher the water would have run south rather than north. To those who have been in the habit of visiting Lake George by the regular route through Caldwell, this may seem impossible, since by that route the entrance to the valley or defile is over morainic accumulations between the mountains two hundred or three hundred feet in height.

But to the east of French Mountain and south of what is called Long Island, three bays—Dunham's, Harris and Van Wormer—which project slightly to the southeast, have natural extensions in stagnant swamps reaching as far south as Caldwell. The watershed between this swamp and the streams upon the other side is a symmetrical drumlin, or glacial hill, so familiar in the vicinity of Boston and between Rochester and Syracuse in Central New York. This drumlin is about a mile long and a quarter of a mile wide, but not quite wide enough to fill the valley; so that upon either side of it the swamp extends toward the southern streams, until a low elevation of not over fifty feet of loose earth is all that separates it from the streams which flow to the south. A short and shallow canal without any rock obstruction might easily be made which would turn the water in the direction of New York instead of toward Montreal. Such is the purity of the water of the lake that if the supply were large enough to make it of much account for so great a city, New York would be sure to lay plans for its capture. But the drainage basin of Lake George is not large, and its safety is assured mainly by that fact.

One other very obvious fact is necessary to complete the story. About the middle of the lake, at what is called the Narrows, the channel is filled with rocky islands, which are said to number one hundred, and here the water is so shallow that special precautions are required for safe navigation. The significance of these facts (first suggested to me by Mr. Prentiss Baldwin, whose map of the glacial terraces about Lake

Champlain was adopted by Professor Dana in the last edition of his "Geology") is readily seen. Lake George, throughout its entire length, lies in a deep trough between parallel mountain ranges, mainly produced by elevatory forces; but this has been still further deepened by streams which ran both north and south, with the Narrows, near the Hundred Islands, as the watershed. Dams at both ends have raised the water just enough to submerge this watershed, and thus we have one lake, with a deep basin at each end, instead of two distinct lakes.

So simple is this theory, and so clear are these facts, that they can be taken in at a glance, and need not burden the minds of the tens of thousands of tourists and transient visitors to this beautiful region; while a recognition of them can but add an intellectual flavor to the enjoyment of the scenes which to many will redeem it from the ennui of mere pleasure seeking. There is scarcely a rod along the shore which does not reveal some impressive evidence of the majestic forces of nature which have produced this temporary reservoir by processes so incidental and easy that all similar human efforts are dwarfed in the comparison.—The Independent.

[FROM THE NEW YORK SUN.]

COLORADO'S GOLDEN ERA.

A GOLDEN era has dawned upon Colorado which will probably eclipse the wonderful development of mining in Colorado resulting from the discoveries of lead carbonates in Leadville in 1879 and continuing until the slump of silver in 1893. The present condition of the many mining camps in Colorado to-day indicates a most hopeful development. Never in the history of the State has so much valuable work been done as during the closing mining season. To-day Leadville and Aspen, the two great silver camps, are shipping a greater tonnage of precious ores to the reduction works in the valley cities than ever before in their history, and there is scarcely a known camp in the State which cannot show a greater output from its mines this year than during any year since their discovery.

The knowledge of mining has been advanced in many ways. Fifteen years ago practical mining men were few, to-day an army of practical miners have been educated. They understand how to prosecute work in a mining territory to the best economic advantage. Methods of ore reduction have been extended and cheapened; methods of mining have improved; the application of electricity as a motive power has made formerly unprofitable property yield a fair revenue. A golden era is now predicted confidently.

Foremost among the fields is Cripple Creek, which now has a monthly output of $1,000,000 in gold. This district has a population of 30,000, and the daily scenes of the camp remind the old timers of the booming days in Leadville, in 1879. The district for an area of six square miles presents a spectacle unprecedented in Colorado's mining history. On every one of the several rounded hills shafts are sinking, steam hoists are puffing vapor into the clean air, men are digging trenches to find the outcropping veins of gold ore, and teams are hauling to market sample lots of the well-proved rich ore of established mines.

Of the developed mines the first in importance is the Independence, the property of W. S. Stratton, until a few months ago a practical carpenter and visionary mining prospector. This mine has a shaft 500 ft. deep, with levels beginning at each 100 ft. of depth. The ore was mined in the shaft as it was driven, and in sinking the shaft the yield alone amounted from $50,000 to $200,000 per month. The ore has paid for the magnificent mining machinery set up in a commodious shaft house, has defrayed all expenses, and has given the owner a bank account that has been sufficient to make him independent for all time. Stratton has steadily purchased other properties until he is to-day the largest holder of valuable claims and mines in the district, and is the prospective Cræsus of Colorado. He has as yet got out the rich gold ore from only the upper level, leaving the ore between the first and the fifth levels, a distance of 400 ft., to be taken out at his convenience. It is estimated that the ore in place in his mine is worth $8,000,000, while the ore below the 500 foot level is yet to be uncovered. Stratton has never placed a price upon his mine, and declares he never will. The mine is easily and economically worked, and the ore is so rich that a few tons a day means a revenue which is beyond the capacity of this plain man to consume. It has already become a problem to Stratton how to dispose of his money.

Probably next in importance is the Portland. This property, after several years of litigation over the title to several of the claims included in the company's present holdings, is now intact as to title, and is yielding a princely revenue. It is a stock company capitalized at 3,000,000 shares of a par value of $1. The company owns fourteen claims, aggregating over 100 acres of patented ground, and has already paid over $250,000 in dividends. The company is building an immense shaft house upon the property, and will expend $85,000 in improvements before Jan. 1. The company employs 335 men. A year ago the Portland owners had less than $1,000 in the treasury, but they have settled with adverse claimants, paid the costs of expensive lawsuits, built improvements, and have developed the mines on their property out of the yield of rich ore veins found on the premises. The company has paid off $300,000 indebtedness, declared several dividends, paid for wages about $25,000 a month, and still has money to spare. Messrs. Burns, Doyle, Barnan, and Stratton are believed to be chief holders in Portland stock. During the years of litigation, much of the stock was peddled around Colorado Springs at very low prices. It is this loose stock which is now being traded for upon the mining exchanges. The main shaft on the property is over 400 feet deep, and the ore has been continuous and increasing in richness with depth. Over $1,000,000 worth of ore is now available in the mine and drifts, and further development only adds to the promise of future richness.

The Victor is one of the oldest mines in the camp, with deep shafts and drifts opening the entire ore body. This is a stock company, and much of the stock has been sold in London and Paris during last year. Dividends of $20,000 a month are paid regularly. A recent shipment of 500 tons was made to the cyanide works in the camp, and it is the expectation of the superintendent that this will net the company $10,000. One lot of five tons yielded $15,000. The ore continues to show more surprising richness with development.

The Anaconda, with a capital of $1,000,000, the stock now being quoted (though but little offered) at 65 cents, owns twenty claims, aggregating 145 acres of mineral property. This is a property where the ore can be quarried at the surface, with millions of tons in sight. The ore is low in value, but a process has been found which, the management says, will yield a handsome profit. A large reduction plant is now building in Florence, near the coal and oil fields, to treat the Anaconda ores, and when the works are completed shipments will begin. It is upon the promise of the result of the reduction process that Anaconda stock is held, and the prediction is made that the stock will go to par.

During the past summer much of the Cripple Creek property was developed under leases. The Anchoria-Leland Company, capitalized for $600,000, leased during the summer one of its claims for a small sum. The lease was afterward bought by a Black Hills miner who did not have a cent to pay down, but took it upon an agreement to work the claim and pay for the lease if he struck mineral. The lease has yet seven months to run, and since the mineral was struck the company has offered $50 000 for the surrender of the lease. The shaft is only 250 feet deep, yet the tonnage already shipped is netting the fortunate holder of the lease a handsome revenue. When the company gets back its property it will have five shafts reaching into an ore body showing a length of 300 feet, the value of which can only be estimated rudely. The ore grows richer with depth, a general characteristic of the camp. The stock in the Anchoria-Leland Company sold in June at 4 cents, and in a few months it went to $2, making a number of Colorado Springs people rich who sold the stock at the high figure.

The C. O. D. mine was the first property to go to outside investors, a syndicate of French capitalists being the purchasers, the sum paid being $260,000. The company operating this mine is called the Rebecca Company, and the property is being elaborately equipped. Recent strikes of gold-bearing rock make the C. O. D. one of the wonders of the camp.

To swing around the "Golden Circle," as the carriage drive past the great producers is called, is to receive illustrations innumerable of the way rich mines are being developed into great dividend payers. The Anchoria-Leland strikes of the late summer were followed by others in adjoining claims, until at this time forty shafts are being driven on Gold Hill to reach the same gold-bearing rock. Mineral Hill, to the north, is now the next hopeful scene of great excitement. The wash is deeper there, and shafts must go down further to reach the gold-bearing sylvanite. The number of producing mines daily increases. Two prospectors with windlass will draw up a half ton or a ton of rock, which will be purchased by the smelters at prices astonishingly large. These shallow holes in the ground are paying their own way; consequently the owners are not eager to sell unless they can get a price sufficiently large to induce them to part with their property. With a formation so different from all previously accepted geological theories, with a great area of prospective mining territory, Cripple Creek has become a center for speculation in mines and in stocks. The owners of claims do not care to bond or lease their holdings, but reserve their properties for cash offers.

The gold strikes of Leadville became known through John Campion and his great "Little Johnny" mine. This discovery of gold in a new mining place in the Leadville field has resulted in the exposition of a theory about a "gold belt" which has not yet been fully demonstrated. The gold ore zone is believed to be three miles long, and the ore so far found ranges from $40 a ton to $1,000 for a sackful. The Ibex Company, which operates the Little Johnny, with other adjacent properties, has already taken out over $3,000,000 while sinking shafts and running levels. The company has not begun to "stope," yet from its four shafts and many levels it has enough ore in sight to keep the machinery busy hoisting rock for ten years. The output for the mine in October was $400,000. It rivals the dreams of Aladdin to listen to a detailed description of the ore discoveries of that one company.

Early last spring many shafts were started to find this wonderful gold deposit, but the great flow of water caused large expenditures of money for pumps, and the progress of work in the Leadville gold field consequently has been slow. Recently the Turbot mine struck a new ore chute bearing silver values astonishingly high. One streak of ore assayed 2,000 ounces in silver. The Bison is producing 150 tons daily of argentiferous iron ore which has a value of about $10 per ton. An immense body of this ore is in sight. The Wolf Tone, one of the oldest mines in Leadville, is shipping over 100 tons daily of sulphides. Down in the lower workings of the Maid and Henrietta great bodies of carbonates are still yielding a handsome profit. The old mines with the new properties of the gold belt are furnishing a tonnage to the railroads which is most reassuring to the permanency of the camp.

Aspen, with its entirely silver-bearing ores, has struggled against adverse fate. A plan of leasing has been made, however, which is a marvel of the mining world, and the result is that the great mines are being worked at a fair profit, although little new work is permitted and as much ore is shipped out now as at any time in the history of the camp. The Della S. is shipping 3,000 tons per month through the Cowenhoven tunnel, in itself a remarkable transportation company which furnishes drainage, light, power and cheap transportation of waste and ore values to eight mines whose combined output is 5,000 tons per month.

On Smuggler Mountain the Mollie Gibson, Smuggler and Free Coinage have combined to battle with the great underground flow of water with magnificent pumping plants, and a shipment of 3,000 tons per month can be maintained. On Aspen Mountain the Durant and the Aspen are shipping out through the Durant tunnel 1,000 tons, the Durant Compromise another 1,000 tons, and the Bonnybel 1,200 tons monthly.

The Free Coinage shaft and tunnel enterprise will open up the great silver lodes to a depth of 500 more feet, and will serve the same mines now operated through the Cowenhoven tunnel. Aspen has magnificent areas of silver-bearing veins, but the camp demands great sums of money to operate its mines properly. In the language of mining circles, all Aspen mines are "big propositions." Once the Aspen stocks were greatly sought after for speculation. They are now considered excellent stocks for a long-time investment. New and important strikes have been made in the vicinity of Aspen, showing a widening of that exclusively silver-bearing region.

San Miguel County, with Telluride as a base of supplies, has made great progress during the year. The Tom Boy mine is the wonder of that camp. It had been abandoned for years, when last spring a new company secured a long lease upon the property, put in new machinery, and is now sending weekly shipments of gold bricks to the Mint. The income to the stockholders of this mine has grown to marvelous proportions within a few months. Telluride men assert that the Tom Boy is the greatest gold mine of the world, but the Cripple Creekers say that Stratton's Independence is a greater producer. There are half a dozen other great mining companies operating in Telluride upon new methods of ore treatment, and the outlook is good for a number of more producers to be added to the list next year. A new territory has been opened up lately, called San Rita, which gives assurance of becoming a permanent gold camp next season.

About Silverton the mining revival resulted during the short season in greater shipments of silver and gold ores than has been known in the history of that camp. The great event of the year in Silverton has been the improvements made upon the property of the Silver Lakes mines. These are situated upon a mountain side, 12,000 feet above sea level, where the transportation problem was serious. Until this could be solved the mine was valueless. Now a tramway 8,600 feet long, operated by electricity, has placed the Silver Lakes mines upon a permanent paying basis, and the mines are to be worked without interruption during the entire year, winter and summer. The Silver Lakes Company can treat profitably 150 tons per day. The mining revival spread up into Maggie Gulch, where a dozen new companies began operations during the year. In another year Silverton will be the center of a very lively producing camp of silver and gold bearing ores.

Advancements have been made at Ouray, where the Virginius mine, with its great Revenue tunnel, can produce pay ore for ten years to come at a profit. Several properties there are yielding a fine revenue to respective owners, and one new territory has been opened up advantageously during the summer. Lake City, where the Golden Fleece has been earning a fortune to its owners, saw a number of old properties reopened during the season, and that camp another year will advance under the impetus of the boom.

The older camps of Central City, Black Hawk, Idaho Springs, Bowlder, have been extremely prosperous because of the investment of about all the Eastern money that has come to the State during the last two years. Old mines have been equipped with new and heavier machinery, so that explorations may be made at greater depths, but the same old style method of stamping out the gold is still in general use in those camps. London capital is interested in a great drainage and transportation tunnel enterprise now rapidly progressing in the district of Gilpin, with headquarters at Idaho Springs. The Lamertine, Lincoln, Shafen, Stanley, and Crown Point mines, near Idaho Springs, are now dividend payers. Prospectors and owners are working earnestly to increase the capacities of their holdings.

Of new gold camps Colorado can furnish a large number. Greatest in area and future value is that of Hahn's Peak. In a wide area of placer ground more than sixty lode claims were located during the closing season. Four tunnel schemes are projected with the hope of finding the source of the great placer fields. Two mining men who made fortunes in Aspen have undertaken a placer enterprise of gigantic proportions at Four Mile in that district. They have secured about all the water supply of the Four Mile country, and have constructed a canal extending for over forty miles to bring water to their immense holding of placer ground sufficient to work a dozen monitors. The gravel will pay from ten to twenty-five cents a cubic yard, and the placers are in places fifty feet deep. The Hahn's Peak country is in a wilderness far from transportation. A few hundred prospectors went there this season and all brought back enthusiastic reports.

The Gunnison gold fields, about twenty miles south of Gunnison City, were industriously prospected during the year with promising results. One claim showed such rich values as to secure a purchaser for the property at $75,000. The assays were all rich, and the slight development seemed to presage a future permanency.

The La Plata gold field is yet to be fully tested. One company has built a fine mill to give a complete test of the great vein of gold-bearing ore they have purchased. The early snows stopped work there for this season before a full demonstration could be had, and the problem is left for another year.

A dozen new fields are left in a prospective state until another season. Old camps have some promise of revival in the reopening of long abandoned mines under new management. The permanent camps are gaining each succeeding month. But it is to Cripple Creek that all eyes are now turned, and that camp will probably be the center of the greatest gold excitement which this country has ever seen. When it is remembered that Colorado and its people have been three years in waking up to the possibilities of the camp, it need not be wondered at that the people outside the State and unfamiliar with mining affairs have been ignorant of the camp, or that they now hesitate to believe that the wonders told of that district actually exist. Investments will be made in Colorado mines possibly for the purpose of speculations similar to that of the Kaffirs, but a foundation has been safely laid by the energy of the people of the State, and mining under any and all conditions will continue to be the great resource of the State. It is said here that the inexhaustible wealth of the Rocky Mountains will remain to incite many generations of men to industry and perseverance in delving for their riches.

NOTES ON GOLD MILLING IN CALIFORNIA.*

By ED. B. PRESTON.†

THE system of reduction of gold-bearing ores with stamps, as at present carried out in California, is the result of progressive improvement during the past forty-four years. The first successful mill in this State was built in the winter of 1850–51, and used steam for power.

Starting with the ancient Mexican arrastra, crushing, with the help of a mule and one man, a few hundred pounds of ore at a charge, we have progressed to the present aggregation of mechanical appliances, as seen in the modern stamp mill, requiring great motive power, and disposing of hundreds of tons of ore in the course of a day. This progression is largely the result of accumulated practical experience on the part of the designers and builders of mills, as well as of the millmen in the handling of the various gold ores. Of late years scientific investigations have greatly aided in improving both the process and the mechanism.

That the results accomplished have been of economic value is evident from the fact that while formerly a yield of 30 per cent. to 40 per cent. of the total gold in the ore was the average obtained, the best mills of to-day are able to more than double these figures. That our methods may still be improved upon, and the margin of wasted gold be further narrowed down, is the point for which all intelligent millmen are striving. While the stamp mill itself had been used for crushing ores long before the discovery of gold in California, since that time it has been greatly improved in detail, and its capacity and efficiency increased, hence what is now known as the "California gold mill" is a very different affair from the clumsy mills first used for crushing quartz in this State. The California gold milling processes and the California millmen are, as a result, finding due recognition outside of their own immediate field of operation, as is evidenced by the increasing outside and foreign demand for our men and milling machinery. The development of the milling process, keeping pace with the improvement of the machinery required for ore reduction, has had the beneficial effect of greatly lessening the working expenses, permitting ores of a low grade to be worked at a profit. California has a great abundance of this class of ores, comparatively untouched, and these must be mainly relied on in the future as the sources of the precious metal. Already, under extremely favorable conditions, ores are being mined and milled in California at a cost of 50 cents per ton, as at the Spanish mine, in Nevada County, where, with Huntington roller mills, ores yielding 85 cents per ton have been worked at a profit.

MILL SITE.

When assured of a constant and sufficient supply of ore, it of the greatest importance that the site for the mill should be chosen with due regard for economic treatment. This necessitates the observance of the following points:

The means of transportation of the ore from the mine to the mill, which should be done automatically, or at least with as little handling as possible, conveying the ore at once to the highest point in the mill, so that it will descend by gravity from one to the other in all the different consecutive operations. Another important feature is, to provide sufficient space for capacious ore bins, which are necessary to prevent a stoppage of the mill through a lack of ore, caused through unavoidable delays in the mine or along the roads. The accessibility of the mill site as regards fuel, water, or electrical transmission, according to the motive power to be used, and their continuity and cost at all seasons of the year, must likewise be considered. The possibility of placing the levels for the different floors on solid rock foundations should be investigated, as stability of the machinery is most essential for successful milling.

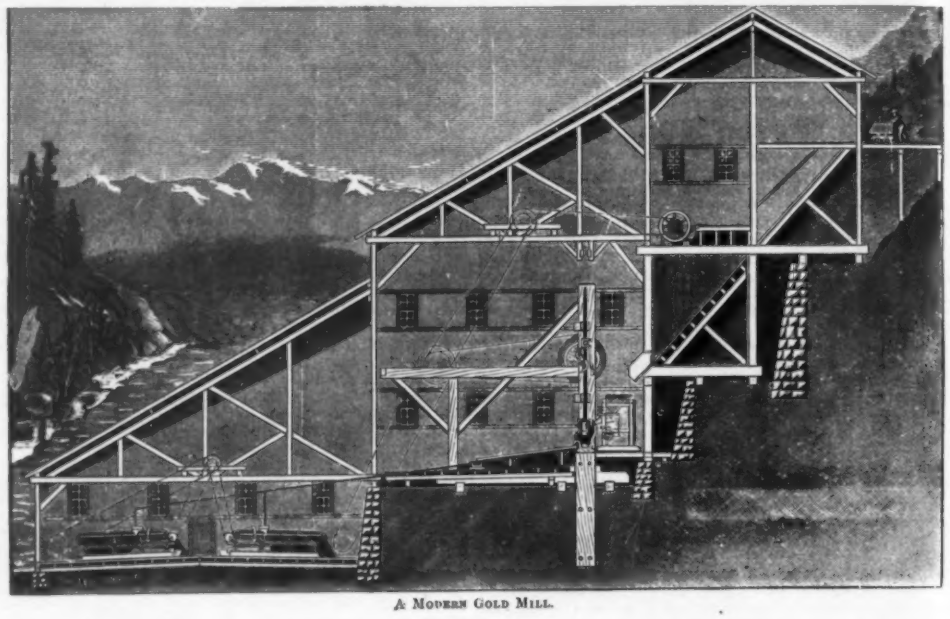
The ideal site would be to have the mill in close proximity to, but below the level of, the collar of the shaft or the mouth of the tunnel, on sloping ground, where the ore can be delivered directly from the mine to a "grizzly" on the upper floor of the mill, to be passed later, without rehandling, through the crushers, ore bins, self-feeders, mortars, etc., while leaving sufficient space for a waste dump. For a mill arranged in this manner, including concentrators and canvas platforms, 40 ft. of fall should be available. If chlorination works are also to be used, a greater fall is desirable.

MILL CONSTRUCTION.

After deciding on a suitable site, the surface should be removed down to the bedrock and leveled off for the different floors. Solidity and accessibility are the chief points to be observed in placing the different parts of the mill. Where required, heavy stone walls should be erected as buttresses. The foundation for the mortars and the proper erection of the battery frames are points requiring particular attention. For the mortar block, a trench is prepared of suitable depth, preferably in solid bedrock, proportioned to the height of the block, and wide enough to leave about 2 ft. of free space around it, which is later filled in with concrete or tailings from the battery. These mortar blocks vary from 8 ft. to 15 ft. in length and are dressed at the upper end to the size of the bedplate of the mortar. In California they can be obtained frequently from a solid cut of a pine tree, or else consist of two or three sawed blocks fitted and bolted together; but where clear timber of the requisite size is difficult to obtain, the block can be constructed of 2 in. plank, as is done in the Black Hills, in Dakota.* There the bottom of the trench for the block is leveled and some sand tamped down, on which two layers of 2 in. plank are placed crosswise and spiked to each other, and made perfectly horizontal. On this foundation a mortar block is constructed of 2 in. planks, from 11 to 14 ft. long, according to the depth of the trench. The planks, which should be of clear lumber, and varying breadths (in order to break joints), stand on end, with their width parallel to the long side of the mortar. They are spiked together and fastened above and below with binders bolted to each other by transverse rods; the upper binders (8 in. × 12 in.) being even with the top of the mortar blocks; the lower binders (12 in. × 12 in.) are 3 ft. lower.

The top of the mortar block should be planted perfectly true and leveled, and where several blocks are placed in line all the blocks should be sawed off to one height. Before setting the mortar upon the block a sheet of rubber cloth, ¼ in. thick, should be placed between, or when this is not obtainable, two or three folds of mill blankets, well tarred, will answer the purpose.

The mudsills should be of square timber, free from sap, bedded in concrete on the bedrock and secured



A MODERN GOLD MILL.

* From Bulletin No. 6 of the California State Mining Bureau. J. J. Crawford, State Mineralogist.

† Hon. J. J. Crawford, State Mineralogist:
In preparing, at your request, this article on the California Gold Mill Practices, I have endeavored to furnish something that should be of practical benefit to actual working millmen who might not come in reach of expensive works on the subject, rather than a further contribution to the literature on gold milling. A demand for this kind of a work is evidenced by the constant inquiry at the State Mining Bureau for former reports dealing in part on this subject.
To W. H. Storms, M.E., my acknowledgments for valuable data collected in the counties of Amador, Calaveras, Tuolumne, and Mariposa are due.
Some of the illustrations are repeated from former bureau publications, and for many of the others I am indebted to the principal San Francisco iron works, including the Union, Risdon, Hendy, Fulton, and the Pelton Company.
ED. B. PRESTON, M.E., Field Assistant.
San Francisco, Cal., January, 1895.

* Gold Milling in the Black Hills, by H. O. Hoffman.—Transactions of the American Institute of Mining Engineers, vol. 17, 1888–89.

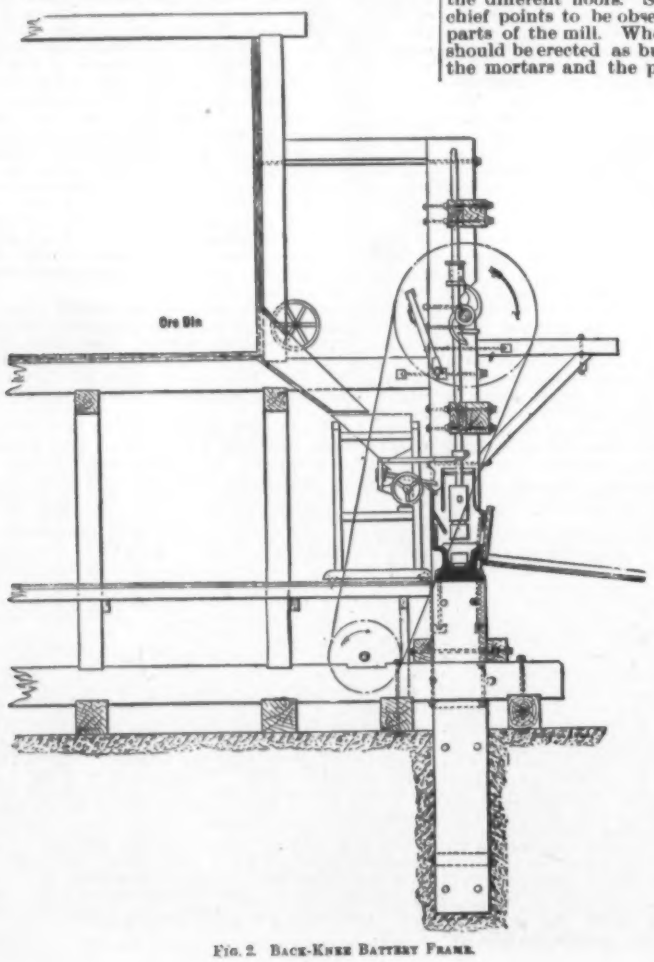


FIG. 2. BACK-KNEE BATTERY FRAME.

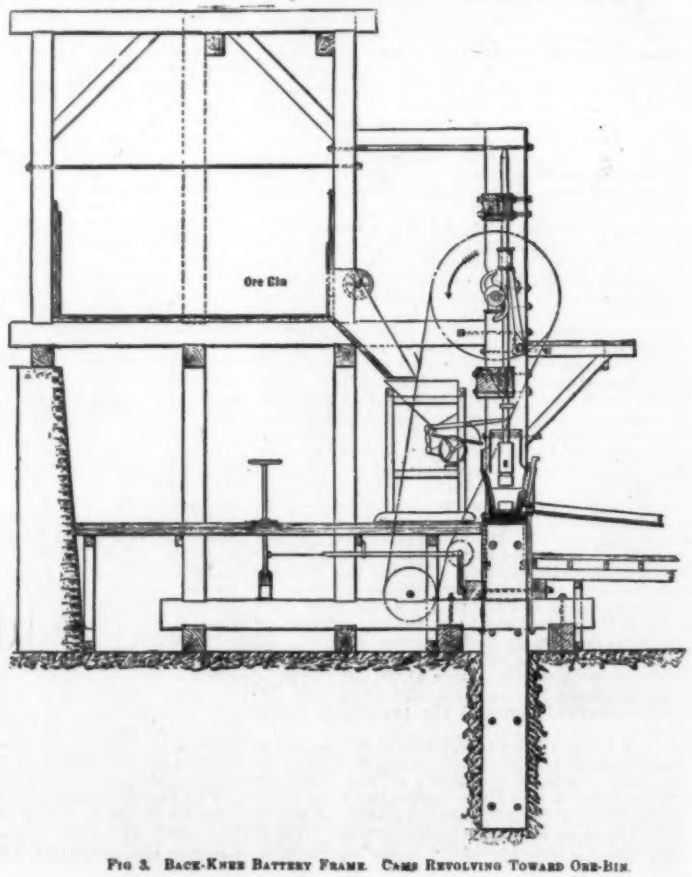


FIG 3. BACK-KNEE BATTERY FRAME. CAMS REVOLVING TOWARD ORE-BIN.

by anchor bolts to the foundation; they also should be bolted to the linesills.

The uprights of the battery frames are supported in various styles; with diagonal braces and hog chains at front or back, or with so-called knee frames. In the former style the brace is placed on the same side as the countershaft, which rests low down on the battery sills. This style is well suited for small mills using stamps not to exceed 750 lb., but for large mills using heavy stamps the knee frames are the more suitable, with the countershaft on a level with the cam shaft. What is known as the reversed knee frame forms a strong, compact construction, but requires the countershaft to rest on the battery sills behind the frame. The accompanying cuts show the construction of back and front knee braces as supplied with mills from the Union Iron Works, of San Francisco.

Fig. 2 presents a view of a back knee battery frame with a Union mortar and square ore bins, showing the latest arrangement of working the self-feeder from a collar on the stem, instead of having the tappet strike the bumper.

Fig. 3 shows the back knee battery frame with the cams revolving toward the ore bin, with a Hayward mortar.

Fig. 4 shows the suspended ore feeder with back knee frame.

Fig. 5 is the arrangement of a front knee battery frame, with Union mortar.

Figs. 6 and 7 show the method of securing knees to the battery posts.

The battery posts are made 24 in. deep and from 12 in. to 20in. wide; the center one of a ten stamp mill being made the heaviest, as having to bear the greatest strain. They are let into the sills and secured to the line timbers by bolts. Besides the braces, the posts are given stability above the mortar by the guide timbers (see Fig. 6), which extend from end to end in one piece, and are let into the posts to which they are bolted. The lower one is placed about 6 in. above the upper edge of the mortar, and the center of the upper one is about 3 ft. from the top of the post. The seat for the cam shaft bearings is cut in the upper part of the posts.

After lowering the mortar on the block, with the planed bottom resting evenly on the sheet of rubber cloth or folds of tarred blanket, it is fastened perfectly rigid by eight bolts, four on each long side, passing through the flange, which is cast on the bottom of the mortar. This flange is 4 in. wide and about 2½ in. thick. The feed floor should be high enough so that these bolts can be conveniently reached, to permit their tightening when required. The journals for the cam shaft, which are placed in the recesses cut out of the battery posts for their reception, are lined up and "babbitted" prior to receiving the cam shaft with its cams. The stems are placed from ¼ in. to 1 in. from the cam shaft, and just far enough from the cams to clear them when dropping. The cam shaft is made of wrought iron or soft steel, from 4½ in. to 5 in. in diameter, turned true, and should have key seats for securing the cams. There should be two key seats, and placed one-third of the shaft circumference apart. At one end of the cam shaft the cast iron "hub" of the belt pulley (with flanges) is keyed on. This pulley is built of wood, and turned true on the shaft. Where there is more than one battery to the mill, it is best to have a cam shaft for each ten stamps, as this permits of repairs, such as changing cams, etc., without stopping more than ten stamps.

The guides (see Figs. 6 and 7, and D, E, and F of Fig. 8), which direct the drop of the stems, are in two sets, upper and lower—the former above the tappets and the latter below the cams—and are bolted to the guide girts by eight bolts. They are best made of hard wood, but pine answers sufficiently well—though the former lasts five times as long as pine. The old style guide (F, of Fig. 8) consists of two pieces of 4 in. plank 14 in. wide, planed on all sides, and of sufficient length to fit easily between the battery posts, with equidistant semicircular grooves, fitting together, for the passage of the stems. A quick and exact way to make these grooves is to clamp the two planed planks tightly together as they are to be placed on the frame, set them on edge, and, after marking off the centers for the five stems, bore out the circle (using the joint line for the point of center) with a long handled auger having an adjustable bit. These are kept in many mills for this special purpose.

Before bolting the guides in place, half inch pieces are placed between the two halves, and adjoining each stem, which are planed down later as the guides wear, leaving but little play for the stem. After boring out the grooves for the stems, and before putting the guides in place, they should be lubricated. A convenient and economical plan is to cut some semicircular pieces of thin sheet iron of a somewhat larger diameter than the grooves, and drive them into the wood at both ends of the channel; then lay the halves level, groove side up, and fill the latter with linseed oil, letting them remain until the wood has taken up all it will absorb, when the remainder is returned to the can, and the sheet iron pieces removed.

If, in a pine guide, those portions occupied by the grooves are cut out square, and hard wood bushings fitted in before boring out, the stem will work parallel to the wood fiber, which reduces the friction, and lengthens the life of the guides; while only the hard wood bushings would need replacing, making the cost of the guides less.

The great drawback to these guides is that when a

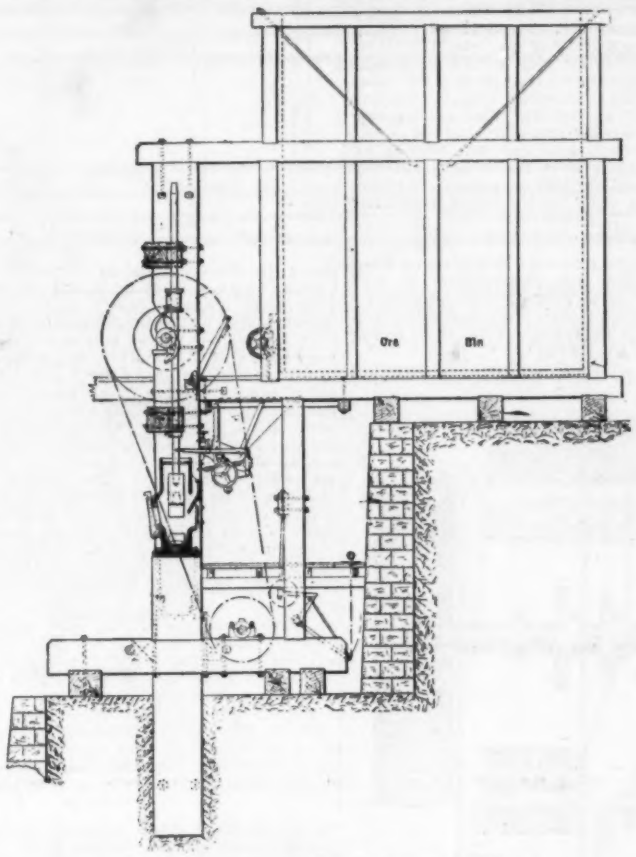


FIG. 4. BACK-KNEE BATTERY FRAME, WITH SUSPENDED ORE-FEEDER.

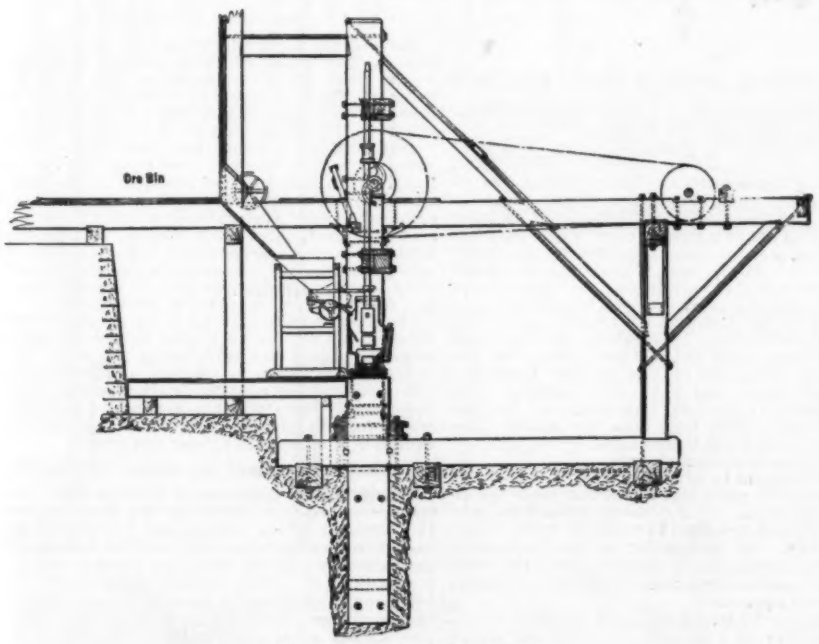


FIG. 5. FRONT-KNEE BATTERY FRAME.

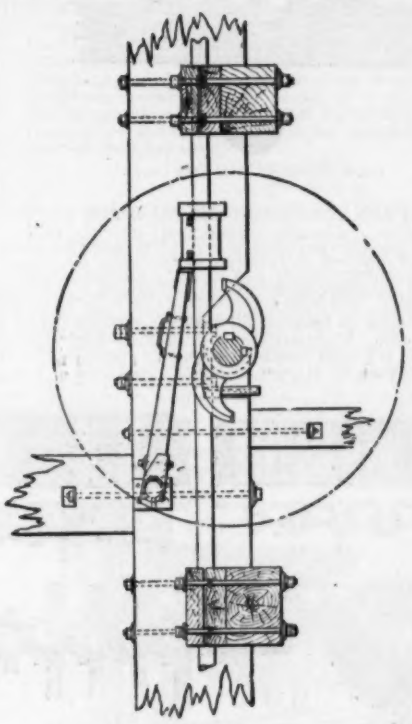


FIG. 6. METHOD OF SECURING KNEES TO BATTERY POSTS.

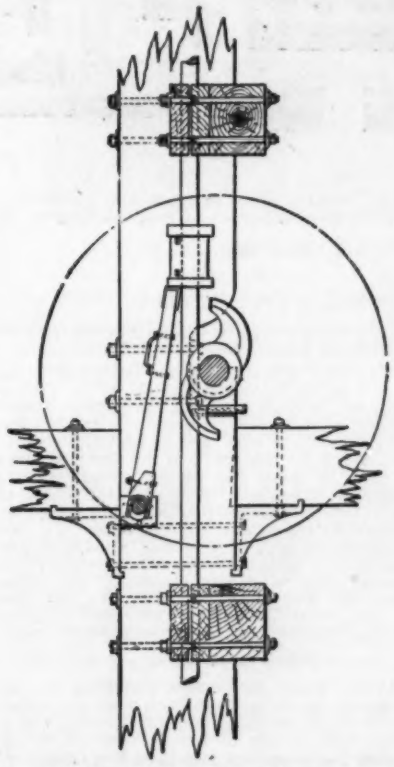


FIG. 7. METHOD OF SECURING KNEES TO BATTERY POSTS.

stem has to be removed, the entire battery has to stop; hence the adoption of separate guides for each stem, being either all iron (see D, Fig. 8) or wooden bushing in iron frames (see E, Fig. 8), which are held in place by wedges and the lips of the iron frames.

For the support of the stamp stems when suspended, wooden latch fingers, or jacks, are supplied. (See Figs. 6 and 7, and L, of Fig. 8.) A jack shaft, 3 in. diameter, rests in bearings attached to the inner sides of the battery posts; on this, cup-shaped sockets ride, in which the wooden fingers are attached, shod at the

FIG. 9. OVERHEAD TRAVELING CRABS.

upper end with an iron plate ⅛ in. thick, and provided with an iron or leather "hand hold" near the top.

For the greater convenience of quickly removing and replacing stems, or cam shafts, large mills are supplied with overhead travelers, or "crabs," in line with the batteries in connection with a chain block and tackle running on plates secured to the roof, shod with iron tracking. To easily reach the cams, tappets, etc., a platform is placed just below the cam shaft.

The feed floor consists of a double board floor of 1 in.

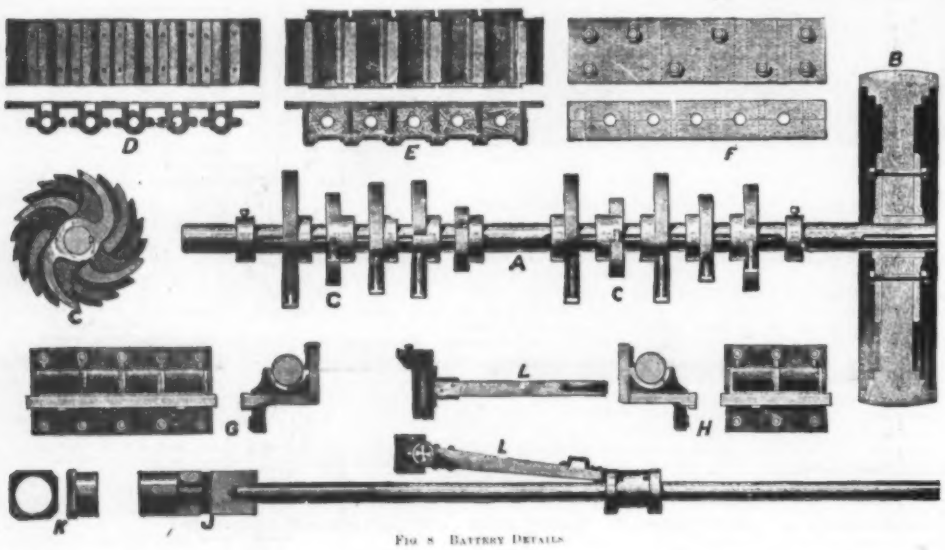


FIG. 8. BATTERY DETAILS.

lumber, with broken joints, supported on joists 18 in. apart, and about 2 ft. below the feed opening in the mortar.

(To be continued.)

RAILWAY SIGNALING.*

By W. McC. GRAFTON, C.E., Signal Engineer, Pennsylvania Lines West of Pittsburg.

TIME is money. This was never more clearly demonstrated than in the age in which we live, when everything must be done in the shortest possible time. Business men transact business in one of our large cities to-day, to-morrow they are in another city five or six hundred miles distant from the first; in order that this may be done, the always accommodating railway officials have been increasing the speed of trains every year. Of course this has led to accidents, as the danger to trains is always increased by very fast running, but instead of reducing the speed, safeguards have been adopted; the track, bridges and rolling stock have been strengthened; the power brake, commonly known as the air brake, has been adopted; and, finally, signaling, or more correctly speaking, fixed signaling, is coming into general use.

FIXED SIGNALING.

In England, twenty years ago, signaling had already grown to be quite important, and was extensively used both for blocking and interlocking, and it represented quite a sum of money invested by the railroads, but fixed signaling was then but little used in this country. It was shortly after 1870 that railroads in this country commenced to put up fixed signals and to arrange them in such a way that it required a number of signals to give complete information or to cover a fixed territory. Prior to that time isolated signals were used for various special points, such as railroad crossings, the ends of yards, etc., but with faster running it became necessary to give the engineer some knowledge of the track ahead, and block signaling was introduced for this purpose. In both block signaling and interlocking it requires more than one signal to make a complete system; for instance, one block signal on a road is of no account, nor can an interlocking be made with but one signal. In fixed signaling, each signal, while complete in itself, bears the same relation to another and to a complete system that each letter bears to the word it helps to make. There is a difference between authorities in regard to the spelling of some words, custom sometimes making it right to spell a word in more than one way, and in signaling the authorities do not always agree; hence there are different styles, forms and systems of signals.

EARLY BLOCK SIGNALS AND INTERLOCKING MACHINES.

The first block signals used in this country were made here, but the first interlocking machine used in this country was made in England and erected here under the supervision of English mechanics. This machine was put up at East Newark, on the New York division of the Pennsylvania Railroad, in 1874.

At the Centennial Exhibition, held in Philadelphia in 1876, there was a model of a Saxby & Farmer interlocking machine. In 1875 there were some machines built in this country which were put into service on the New York Central Railroad, and some were also put into use on the Pennsylvania Railroad in 1876. These were built by the railroads at their own shops, as were all the earlier machines, except those brought from abroad, but I do not know of any road that is at the present time building its own interlocking machines, for experience has shown that it is more expeditious and less expensive to purchase from the regular manufacturers of such apparatus. The earlier machines constructed by regular manufacturers or signal companies were all erected and put into service by the signal companies, but now the larger railroads purchase finished machines and necessary construction material and then erect the machines with their own men.

INTERLOCKED SIGNALS.

Although block signaling was the first form of fixed signaling to be introduced into this country, we will here first take up the interlocking of switches and signals, as the practice in interlocking is much more uniform than that of block signaling. The interlocking of switches and signals consists of:

1. The arranging of a number of required switches so that they will be as near to a central point as is possible.

2. The arranging and placing of a fixed signal for each track connected with the switches.

3. The arranging of a machine for moving each of these switches and signals from the central point.

(1) Arranging the Switches.—The switches are arranged with a view to having as few facing points in the main track as possible, since facing point switches are not as safe as trailing points, even when they are locked by a facing point lock operated by an interlocking machine. At the same time switches should be kept as close together and as near the signal tower as possible, so that the pipe lines will be short, as the shorter the pipe lines the more positive, safe, and cheap is the interlocking. In England the law does not allow a facing point switch more than 550 feet from the signal tower, but in this country there has been no limit fixed, and I know of several such switches which are over 1,000 feet, and one at New River, Va., that is 2,031 feet from the tower. The danger of the latter point is magnified by the location of the switch on a nine degree curve.

The switches should be arranged in such a way that trains may run from one track to another upon the indication of one signal. It is a disadvantage to have three or four signals involved in a simple train movement, both from the standpoint of the locomotive driver and the operator in the signal tower. The ideal arrangement requires the smallest number of signals to fulfill a given purpose.

(2) Arranging or Placing the Fixed Signals.—Originally, signals were all indicated by color, but under certain conditions of the atmosphere, sunlight, or backgrounds, the color could not be determined by a locomotive driver until it was too late for him to stop his train at the signal, and running past a home signal when it is in its danger position is a very serious thing. The difficulties with the color signal led to the use of the position signal; that is, a signal that shows one position or shape for safety, and a different position or shape for danger. There are different kinds of position signals used to-day, but the semaphore arm has been almost universally adopted as the best. This is a post with a movable arm pointing to the right, though there are a few exceptions where railroads have the arm pointing to the left. There are some forms of signals that do not show anything for the clear position; this, however, is considered very bad practice, and every signal should show definitely when it is in its clear position, so that the absence of a signal may be taken as an evidence of danger.

One of the first principles of fixed interlocking signals as they are used in America is that tracks, not trains, are signaled; therefore each track has its own signal. The practice in England in this respect is entirely different, as in that country different kinds of signals are used for different kinds of trains.

KINDS OF SIGNALS AND THEIR SIGNIFICANCE.

All signals can be classed under two heads, Home or Stop Signals (Fig. 1), and Distant or Caution Signals (Fig. 2). The home signal in its danger position means

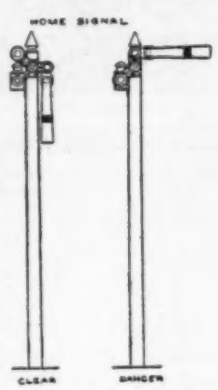


FIG. 1.

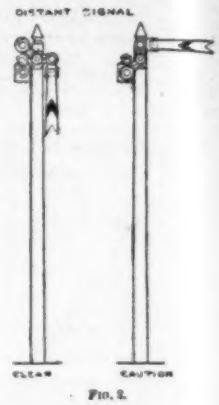


FIG. 2.

stop; the distant signal in its caution position means that a train can run past it, but the locomotive driver must bring his train under control so as to be prepared to stop at the home signal. Distant signals are only required at places where the speed of trains is very fast, and they simply give advanced information in regard to the state of the home signal. The home signal is a semaphore with a square end arm. The distant signal is a semaphore arm with a notch cut in the end. From the latter characteristic it is commonly called a forked end or fish tail semaphore. The home signal at night shows a red light for danger and a white light for safety. The distant signal at night shows a green light for caution and a white light for safety, except on one or two railroads where a red light is used to indicate danger, green for clear, and a combination of red and green for caution. The home signal is of two patterns, high (Fig. 1) and low, or dwarf (Fig. 3). High home signals are used for tracks

FIG. 3.

in their right or usual running direction, and low or dwarf signals are used for tracks in their reverse running direction; as, for instance, to signal a train which is going from side track to main track or from side track to side track.

LOCATION OF SIGNALS.

Each signal is placed on the right hand side of and next to the track which it governs (Fig. 4), except where there are other tracks so close that it would be dangerous to so locate it, in which case the signal is placed on a bridge over the right hand rail of the track governed (Fig. 6), or on a bracket post outside of the tracks (Fig. 5). If more than one track is to be signaled from this bracket, the posts on the bracket stand in the same relative position as the tracks. If there are any tracks intervening that are not to be signaled, a short post without a signal is used to represent each unsignaled track (Fig. 5). Where there are separate main passenger and freight tracks, the signals governing the passenger tracks are placed higher than those governing the freight tracks (Figs. 5 and 6). As the use of signaling is growing very fast and its importance is beginning to be properly realized, I think it will not be very long before all signals will either be placed on a bridge over the right hand rail of the tracks which they govern, or else the tracks will be spread and the post put in its proper position, thus doing away with the bracket post. Spreading the tracks for this purpose has already been done on some railroads, and it is the proper thing to do.

NUMBER OF ARMS ON HOME SIGNAL POSTS.

Where one or more tracks diverge from the main track, two arms are placed on the home signal post; the top arm giving indications for straight through, high speed movements only, and the bottom arm giving indications for all diverging or slow speed movements (Fig. 7). The distant signal shows clear for high speed movements only. Where one or more tracks diverge from the main track, the old method was to place an arm on the home signal post for each diverging track, the top arm for the first right hand track, the second arm for the second right hand track, and so on down the post. This, you will readily see, would bring the main or high speed arm in a different place on the post at different interlockings. For example, if you had three tracks diverging to the right and one to the left, the main track arm would be the fourth from the top (Fig. 8); if you had one to the right and two or three to the left, the main track arm would be the second (Fig. 9); if all diverged to the right, the main track arm would be at the bottom (Fig. 10); and if all diverged to the left, the main track arm would be at the top (Fig. 11). This was confusing to the enginemen, as they had to remember all tracks at each interlocking. The next plan tried was to emphasize the main or high speed track by making the arm longer than the others, and while this answered the purpose in daylight, at night the lights were all the same and no distinction could be seen. There are still a few railroads that follow this latter practice, but I believe the majority have adopted the practice

* From the Bulletin of the University of Wisconsin, No. 6.

of placing but two arms on the home signal post, and the high speed track is emphasized mechanically by placing the arm for this track always on the top, and using the second or bottom arm for all diverging tracks.

The Pennsylvania lines west of Pittsburg were the first to adopt this practice of using but two arms on a post. This arrangement of the signals shifted a part of the responsibility from the engineman to the operator in the tower. When a separate arm or indicator was used for each track, it was presumed that the engineman knew just what track he was to take, and if that particular arm or indicator did not show that his way was clear, he would stop, although he might have a clear signal to proceed on some other track. This caused unnecessary delay, as the operator often had orders to run a train into a different track from the one that the engineman was in the daily habit of taking, and the enginemen were therefore instructed to proceed at once when they got a clear signal and not question what track they were going onto. This showed the uselessness of extra arms or indicators, as the enginemen under the new orders had but one of two things to do: 1, run fast if they received a clear indication from the top arm or, 2, run slow if they received a clear indication from the bottom arm, until they passed over the switches and saw what particular track they were on. If in the latter case the track should be the wrong one, the operator was responsible for the mistake, and not the engineman. Some one may say, I thought you could not make a mistake with an interlocking machine? The reply to this is, no mistake can be made with the machine, as each switch is properly locked before it is possible to give any clear signal, but since the machine is arranged for

FIG. 7

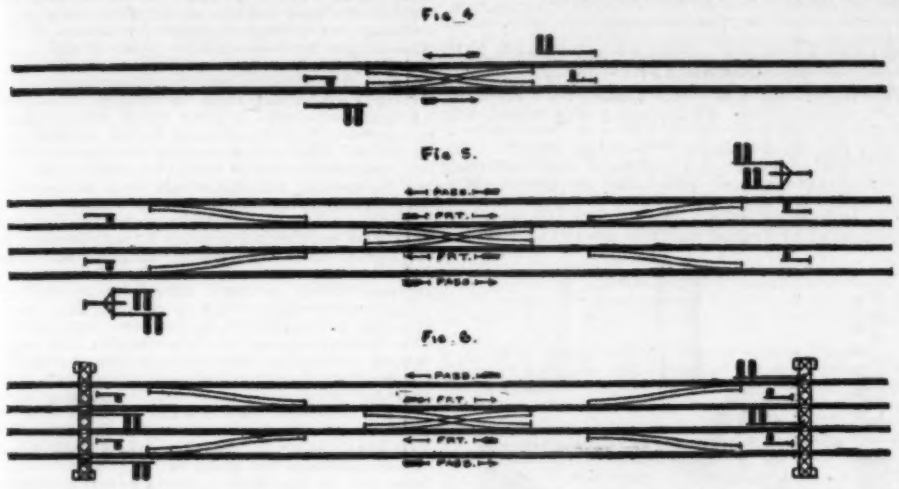
FIG. 8.

the same signal to show clear for different tracks, the operator may set the switches so as to lead a train into a track that it was not intended to occupy. Such a movement on the part of the train when protected by the interlocking leads to delay, but it cannot lead to accident.

NUMBER OF ARMS ON DISTANT SIGNAL POSTS.

The distant signal has but one arm and shows clear for the high speed track only. This makes it simpler for the enginemen, for if they get a clear distant signal, they know that everything within the limits of the interlocking is set clear for them to run through at high speed; but if the distant signal is at caution they reduce speed, prepared to stop at the home signal or to proceed slowly onto a siding, if they get a clear indication from the bottom arm. All trains are required to run slowly when going in on sidings. It is possible, however, that the top arm may indicate a clear track when the train reaches it, though the distant signal indicated caution. This only happens when the operator has been careless about pulling his distant signal clear or some other train has been using the switches and he did not have time to pull it clear, and the engineman simply proceeds on his way as rapidly as possible.

This expression, "pulling a signal clear," may be misleading. It comes from the fact of having to pull a lever in the signal tower to get the signal clear, when we really push the signal to its clear position. I



mention this because it is important that all signals should be pushed, not pulled clear. The signal wires run from the machine lever to a balance lever on the signal post; this balance lever is connected to the signal casting by what is called the up and down rod; this rod is fastened to the signal casting back of the center and has to push it clear. All signals are arranged so that if any connection breaks the signal will gravitate to the danger position, and counterweights

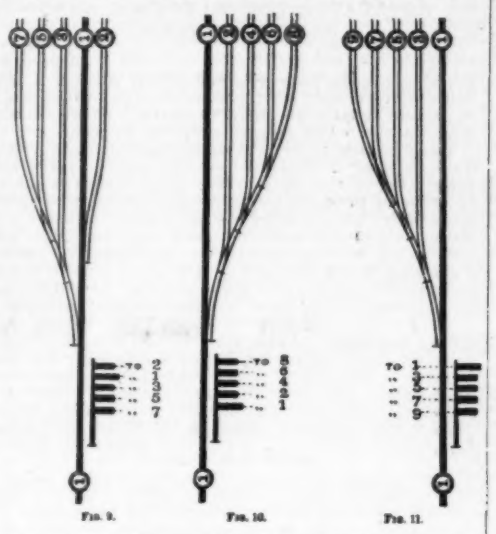


FIG. 9. FIG. 10. FIG. 11.

are used for that purpose; and if you make the up and down rod connection to the back of the signal casting, it will always help to pull the signal to danger, while if made to pull the signal clear and anything broke, it would help to hold it clear.

INDICATORS.

The indicator was used very extensively up to 1890, but since then most roads have abandoned its use, as

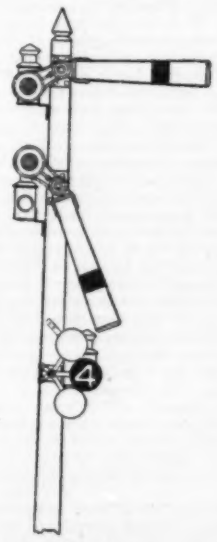


FIG. 12.

practical operation showed it to be of very little value, while it was very expensive to put up and maintain. I want to say right here about these indicators (and it will apply to many things that have been and are now being introduced) that they were put up to carry out a theory rather than to make it easier for the engineman to read the information it was desired to convey. These indicators were round iron disks about six inches in diameter for dwarf signals and twelve or fourteen inches in diameter for high signals (Fig. 12). There was a number or letter cut in each one to correspond with the track number or letter for which the indicators worked. A piece of opal glass was placed back of these numbers which showed white in the daytime, and a lamp was placed on the post back of the indicators to show the numbers at night. These indicators were designed to take the place of an arm; that is, instead of having an arm for each diverging track, one arm would be erected for a number of tracks and one indicator to work with it for each track. The indicators were placed on the post just below the arm, and when the arm was pulled clear, the indicator which carried the same number as that of the track for which the switches were set would come up or show, but practice proved that the enginemen cared very little for the information given by the indicators, and there are very few of them used to-day.

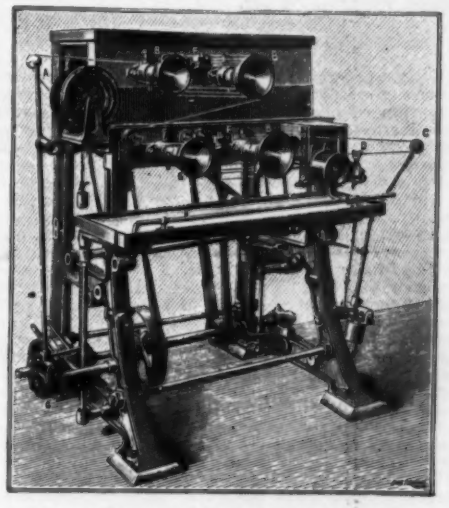
SIGNAL REPEATERS.

It sometimes happens that a signal must be located where the operator in the tower cannot see it. For such situations there is an electric signal or repeater that can be placed in the tower, which works with the signal arm in such a way as to show whether the arm responds properly to the actuation of the lever; but our mechanical apparatus works so accurately that we do not feel the need of the electric assistant and very few of them are used.

(To be continued.)

NEW WIRE DRAWING MACHINE.

INNOVATIONS in wire drawing are rare. We desire to call attention to one that is destined to have a certain success. Since the great extension of electric installations and the continually increasing use of wire in tapestry, church ornaments and ecclesiastical and military vestments, a method has been sought of rapidly and cheaply producing large quantities of wire of all sizes and all kinds. The simple draw plate employed for coarse wire is well known, but when it is necessary to produce the wire as fine as silk employed in dress trimming, the operation, were a simple draw plate used, would be lengthy and troublesome. The first machine to mark a progress in wire drawing was the one known as the "Multiple," but, despite the advantages of this, it had the inconvenience of requiring fifteen belts, fifteen shafts and as many lubricators



NEW WIRE DRAWING MACHINE.

Mr. Allard Latour, of Lyons, appreciating these defects, has devised a very simple and practical machine, which we have seen in operation at his works, and which we figure herewith. It comprises from fifteen to nineteen draw plates and is but five feet in width; besides, it has but two belts for actuating the bobbins. The wire starts from the bobbin, A, passes over the front roller and winds around the superposed cones, B. From the top cones the wire passes to the bottom ones and then over the roller, C, and winds around the bobbin, E. A draw plate carrier, D, distributes the wire automatically. When, for any reason or other, the wire breaks, the carrier falls and disconnects the gearing, H, and the machine stops instantaneously. In order to give an idea of the value of this machine, we may say that a single operative can produce from 90 to 100 pounds of wire a day.

This wire is so fine that it takes 80 000 feet to make a pound. We believe that the machine will render great services in the art of wire drawing.—La Nature.

MEMORANDUM ON THE BRITISH ASSOCIATION SCREW GAGE FOR SMALL SCREWS.

By R. E CROMPTON, M. Inst. C.E., Pres. Inst. E.E.*

As a result of the two reports presented by the committee appointed by the British Association to design a standard screw gage for small screws, a large number of users, including H. M. post office, have adopted them.† In 1890 the London Chamber of Commerce appointed a committee to forward the question of making the British Association screw gage universal among electrical manufacturers, and a circular was sent round to the entire electrical manufacturing trade, with the result that with hardly any exceptions the whole trade promised to adopt the screws, and thus insure the extremely desirable result of making all the same screws used in electrical apparatus interchangeable. It is, however, much to be regretted that a considerable number of users of small screws (the principal offenders having their works in Birmingham) are still using other gages, and thus complete uniformi-

* Read before Section G of the British Association meeting at Ipswich.

† These reports are printed in the Journal, vol. xxxi, p. 115; vol. xxxii, p. 1026.

ty has not been obtained up to the present time. One great difficulty in this matter has been that of obtaining standard gages which could be referred to in specifications or orders for such screws. Wherever it is desired that the screws should be thoroughly interchangeable it is necessary in such specifications to have a paragraph somewhat as follows:

"Testing.—Each box of screws will be tested thus: A handful of one dozen screws will be selected at random from each box; these will be tested both as to the screw portion and the plain portion of the shank by being respectively screwed or pressed through the corresponding maximum and minimum gage holes in the standard plates supplied on loan with the order, and which must be returned with the finished screws. Any screw which cannot be screwed or pressed by hand into the maximum female gage, or which can be screwed or pressed by hand without forcing into the minimum gage, will be rejected. If more than one screw in each dozen thus tested is so rejected, the whole box will be returned to the contractors."

Four years ago I found it necessary to have standard plates made for the purpose of ordering screws to the above specification. I had a number of such plates prepared, but found the very greatest difficulty in getting them made so that they would fulfill their required duty, the makers giving as an excuse that there was no standard B. A. gage then existing to which they could refer. This difficulty can only be removed by a complete set of standards being made and deposited either with the Board of Trade or at the Society of Arts, or with a similar central institution; and it is highly desirable that the British Association should either call together the surviving members of the original committee or form a new committee to consider the question of making up these standard gages and deciding on the place where they are to be deposited.

One question for the committee would be the requisite allowance of clearance between the absolute diameters of the various sizes as laid down in the report of the committee and the sizes of the maximum and minimum gage holes in the gage plates.

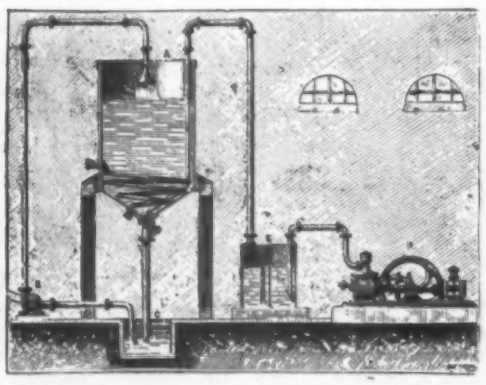
Another point of importance in order to make this standard screw gage universal would be the issue of a short descriptive report, with illustrations, giving the sizes, clearances in gage plates, best method of reproduction on English lathes of these screws, together with a few sectional drawings showing the shape of thread, rounding off, etc.

STERILIZATION OF OILS.

UNDER the name of sterilization, we make known a process that permits of assuring the indefinite preservation of oils without modifying the properties peculiar to each of them, without altering their taste and aroma, and, in a word, without changing their nature.

Up to the present, through an application of the labors of Pasteur and Appert, we have succeeded in preserving wines, beer, cider, milk, meat and vegetables, but, unfortunately, the method cannot be applied to oils. Heat alters edible oils and communicates to them a taste sui generis which it is impossible to destroy or disguise. The commercial value of heated oils is considerably reduced. In order to attain the object sought, we have started from the following principle. Neutral and pure fatty bodies are preserved indefinitely and never become rancid. The cause of the alteration of oils is the presence of foreign substances—mucilage, albuminoid matters, fatty acids, color, etc. Therefore, to eliminate the foreign matters contained in the oils by a simple process, in the cold way, is to assure their preservation, and, at the same time, to give them a greater commercial value.

The following is the process that we use and that serves to give pure oils: The oil is first completely neutralized by shaking it up with a mixture of borate of ammonia and aluminate of soda. These materials are in fine powder and are put into the oil in a proportion increasing with its acidity. The apparatus used is figured herewith. The oil is put into the receptacle, A, and is agitated by a current of carbonic



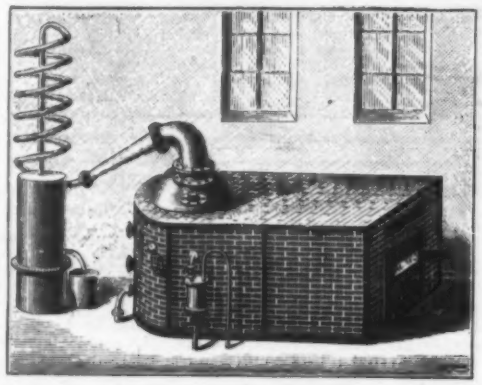
APPARATUS FOR STERILIZING OILS.

acid forced in by the pump, D. After five or six hours the operation is arrested, and the oil is left at rest in order to allow the neutralizing material and the fat acids to deposit.

In order to proceed more quickly, filtration may be resorted to. The neutralized oil, in order to be freed from the coloring, odorous and bad tasting matters that it contains, is put into the receptacle, A, with washed powdered pumice stone. A worm through which a current of cold water flows cools the oil, while the pump, D, sends into it a strong current of dry air. The air is dried by causing it to traverse a bath of sulphuric acid contained in the receptacle, E. In order to increase the agitation of the oil, it is made to flow constantly into the reservoir, C, whence it is taken up by the centrifugal pump, B, and sent to the receptacle, A. From time to time chloride of aluminum, in very strong and well cooled solution, is mixed with the oil. The treatment with dry air should last for a day. The oil, after being allowed to rest for some time, is decanted and filtered. It is then white or of a light amber color, and its preservation is assured. The process is applicable to olive, peanut, sesame, colza and other oils. The cost of the treatment does not exceed fifteen cents per one hundred pounds of oil.—A. M. Villon, in La Nature.

MANUFACTURE OF NEUTRAL GREASE FOR LUBRICATION.

NEUTRAL grease is in great demand for lubricating in all the industries. Tallow easily gets rancid and quickly becomes acid. Fossil tallow remains neutral, but has the inconvenience of becoming gummy. We think it well to point out a process of manufacturing neutral grease that may render true services to those interested. We made this process known in 1889 in our work entitled "Les Corps Gras." We have not been heeded in France, but the Americans, who are



APPARATUS FOR MANUFACTURING NEUTRAL GREASE.

practical people, have profited by our advice. Upon distilling oleic acid with lime we produce a body called oleone or isaleone; with margaric acid we obtain a margarone, while stearic acid gives stearone.

These bodies are neutral, do not become rancid, and do not saponify. They behave like mineral fatty materials, but do not present the same inconveniences. In order to prepare oleone, we distill a mixture of 25 parts of dry lime in powder with 75 parts of oleic acid, a residuum of the manufacture of candles. For such distillation we recommend the apparatus of Julien Engelhart, which operates by dry heat. Two hundred pounds of oleic acid give 160 of neutral oil. Upon substituting tallow and other fats for oleic acid, we obtain neutral greases of different consistencies. We can rely upon a rendering of 75 per cent. These neutral greases resist all chemical agents, save chlorine gas; but the latter does not exist in a free state in the industrial applications for which they are designed. They are therefore lubricants that merit the attention of engineers and manufacturers.—A. M. Villon, in La Nature.

AN ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF WHITE LEAD.*

By R. P. WILLIAMS.

WHITE lead is the basis par excellence of white paint. For hundreds of years it has been used, mixed with linseed oil, as the main pigment, where permanent, opaque, white color is desired.

Up to the present time there have been but two radically different processes of manufacture that have proved in any degree successful. These are known as the Dutch and the French processes. The English and the German are only modifications of the same principle as the others. The Dutch process is the only really successful one. I do not propose to go into the details of either of these processes, since they are well known to every chemist, but only to recall just enough of them to serve as the basis of comparison, and as an introduction to the one I am to describe. Both the French and the Dutch, as well as the many modifications of them, depend upon one compound, viz., lead acetate (or better, sub-acetate). This is the compound which has always been regarded as the essential first step in white lead manufacture. The fact is interesting, since white lead as a pigment has been known for more than 2,000 years, and from the earliest times it has been made by the action of acetic acid on lead. The name Dutch process is a misnomer, as the process was introduced by the Dutch or Flemish people over 300 years ago from Italy, where it had been employed for hundreds of years previously. In fact Pliny, in the first century, describes the essentials of the process, and it is said to have been employed in his country ever since his time, though, of course, on an extremely limited scale at first. Indeed, Theophrastus, about 300 B. C., describes the preparation of a white pigment from lead and vinegar. This may have been the acetate or it may have been the carbonate. The new process is a radical departure from all the old ones in not employing acetic acid at all, but in acting upon lead with nitric acid, which is generated by electricity.

The process consists of four reactions, as given below. First, the electrical preparation of nitric acid and sodium hydroxide. Second, the action of the nitric acid on lead, forming lead nitrate. Third, the reaction of lead nitrate and sodium hydroxide to form lead hydroxide. Fourth, the combination of lead hydroxide and sodium bicarbonate to form lead carbonate.

In the first step of the process a solution of sodium nitrate is decomposed by an electric current from a dynamo. The strength of solution required is not important, 10° Baumé, or say one pound to the gallon, being sufficient. This solution is put into a series of cells, constructed of wood, and divided into two compartments by a porous partition. At the plus electrode is fastened a pig of lead, and at the minus a sheet of copper. The solution being run in from an overhead reservoir, and the current turned on, the nitrate is decomposed according to the equation (1), nitric acid collecting at the plus electrode and sodium hydroxide at the minus. The nitric acid at once attacks the lead and forms lead nitrate, which dissolves, equation (2), whereas the sodium hydroxide produces no effect on the copper at the negative pole. Finally, the lead nitrate solution and the sodium hydroxide solution are drawn off separately, and mixed as desired, in quantitative proportions, in a receptacle. The result, as shown in equation (3), gives lead hydroxide as a white, amorphous precipitate and leaves sodium nitrate in solution. This is practically the original nitrate, and its regeneration shows one of the economic excellences of the process, for the nitrate can be used over and over again, as the source of more acid.

It has been found at the experiment station that but little additional sodium nitrate is required for a repetition of the process as complete as the original. The lead hydroxide is then filtered from the sodium nitrate. This is done automatically and continuously, by a rotary filtering device, and the sodium nitrate is pumped back into the original reservoir. The fourth step is, in some respects, the most interesting of all, and consists in adding to the lead hydroxide a solution of sodium bicarbonate (or of the normal carbonate). Reaction (4) at once takes place. It will be noted that sodium hydroxide is the product in solution, and lead carbonate the precipitate. Another beauty of this process is that the sodium hydroxide removes most of the impurities, if there are any, in the lead hydroxide; for instance, it will dissolve any salts of aluminum or of zinc, and it removes organic matter.

These impurities appear in the solution, leaving the precipitate remarkably white. Once more this by-product, sodium hydroxide, by passing carbon dioxide into it, is converted into bicarbonate, and the latter can be used again. Thus the main agent in each of the two principal steps, sodium nitrate and sodium bicarbonate, is made to do duty over and over again, with but slight additions.

$$(1)\quad NaNO_3+H_2O=\overline{N}aOH+\overset{+}{H}NO_3.$$
$$(2)\quad 2HNO_3+Pb=Pb(NO_3)_2+H_2.$$
$$(3)\quad Pb(NO_3)_2+2NaOH=Pb(OH)_2+2NaNO_3.$$
$$(4)\quad Pb(OH)_2+HNaCO_3=PbCO_3+NaOH+H_2O.$$

It is doubtful whether (1) and (2) take place as above, but probably the reaction is as follows, since hydrogen is liberated at the minus electrode:

$$2NaNO_3+2H_2O+Pb=(2\overline{N}aOH+H_2)+Pb\overset{+}{O}_2(NO_3)_2.$$

Let us now turn from the theoretical to the practical part of the matter. The first question which naturally arises is, Will this process, so beautiful in theory and as a laboratory experiment, work on a large scale, and give sufficiently practical results to compete with the other methods of manufacture, and make it a lasting contribution to inventive science?

An experimental station was for several months in operation in Cambridge, Mass., erected and run under the direction of Mr. Arthur Benjamin Brown, the inventor of the process. This was capable of turning out some 500 lb. of white lead per day. Its success was regarded as beyond question. The cost of white lead by this process is more than covered by the gain in weight, and is but a fraction of the cost by the Dutch method. The reasons are, first, in the electrolytic process pig lead is used as it comes from the smelting furnace. In the Dutch it has to be remelted, cast into "buckles" of definite size, and, after the action of acetic acid, from one-third to one-half is left uncorroded and has to be recast.

Second, the process is almost instantaneous, as every reaction takes place rapidly, while by the other mode from two to six months is required.

Third, in materials and labor there is great saving. No free acid is used, either acetic or nitric, and the agents, sodium nitrate and bicarbonate, are used repeatedly. By the old method a plant covering a large area is filled for months with fermenting tan bark or manure, acetic acid and lead, while the process is going on, and at its completion the product is removed with much labor, and has to be thoroughly and repeatedly washed to dissolve out any lead acetate remaining. It must be ground and reground under water, and even then is not likely to be of uniform texture. It is also a poisonous and dirty process. The electric method being continuous is complete the same day, requires but a very small force of men, as almost all the operations are automatic, and is a clean and non-poisonous process.

The texture of the product is almost molecular in fineness, as might be expected from its being produced by replacement in the hydroxide. Hence it needs no grinding. It is so fine as to remain suspended in water for a long time, and in order to filter it a special brand of cloth had to be made, as even filter paper would scarcely retain it.

One of the most important practical questions is: How does paint made from electrolytic white lead compare with that made from Dutch lead in durability, opacity, and covering power? Specimens have been submitted to some of the largest dealers and painters in New England and elsewhere, and Mr. Brown, the inventor, has spent the last two years, aided by a competent corps of assistants, not only in the development of his new process, but in making thorough and systematic tests of the product. Inside and outside surfaces have been exposed to the severest extremes of the weather, to the varied fumes of the laboratory, and to other crucial tests. Dutch paint and electrolytic paint have been exposed side by side for two years, and no difference can be detected in durability or opacity. The covering power of the new paint is considerably greater than that of the Dutch. Experiments vary as to the increased percentage from twelve to twenty, or even higher, but in no case was there found to be a smaller percentage.

What is the cause of such an increase? This leads us to discuss somewhat more fully the nature and composition of white lead made by the various processes. Dutch white lead consists approximately of two molecules of the carbonate to one of the hydroxide,

* Paper read before American Chemical Society, Springfield.

$2PbCO_3.Pb(OH)_2$. This, however, appears not to be constant, as might be inferred from its mode of manufacture. Lead hydroxide is a white, amorphous substance. Lead carbonate is either a spongy, transparent, globular powder, or is crystalline. Whether globular or crystalline depends upon its mode of preparation. Now certain properties of these two forms are quite different, and this difference explains the use of one and the disuse of the other form as a pigment. The globules of the one form are said to be from 0·00001 to 0·00004 of an inch in diameter. These, in the grinding of lead with linseed oil, are supposed to take up the oil, somewhat as a sponge absorbs water. The Dutch process lead is the globular variety, and to this fact has been attributed the greater body and permanence of the paint made from it than that made by most other processes. The crystalline variety of the carbonate is found not to absorb oil to anything like the same extent as the globular, no matter to what degree of fineness it is ground, the surface of the minute crystals being impervious. Half a century ago Thenard invented the "quick process lead," or "French process." This is now carried on in Clichy, France, and some other places, and sold as "Clichy white." It is made by dissolving litharge in acetic acid and then passing into the sub acetate of lead solution formed, carbonic acid gas. Thus is formed neutral lead carbonate. It was at first thought to be a revolutionary process, but it soon became apparent that the product did not give the capacity or body which Dutch lead gave, and of course it lacked permanence. Made in this way, the carbonate is crystalline. Under the brush it is found not to cover as much surface and not to spread as well, or it is said to lack "body," although of the same composition as the other. Other rapid processes—and there have been hosts of them—have invariably met with no better success, for the reason that the carbonate formed is the crystalline instead of the globular variety. To this fact we may mainly attribute the long-continued use of Dutch process lead. The committee of experts appointed by the British home secretary visited forty-six works, and found only one using the precipitation process and three the chamber process. They say: "While some of the substitutes are cheaper to make, and far less poisonous, yet they are far from equaling the Dutch lead as a pigment. Neither can they recommend other processes than the old Dutch process for manufacturing the product."

Thus we see that, until now, no cheaper method has been found for producing the globular variety. The electrolytic process does produce the globular kind, and a finer variety even than the Dutch; so fine, in fact, that it was almost impossible to find a filter that would retain it. This probably accounts for the superiority of the electrolytic brand, as regards body and covering power, over any other kind produced. Experiment shows that the pure carbonate will do as well as mixture of carbonate and hydroxide. By the new process it is easier to make either the pure carbonate, or a mixture in any proportion of carbonate and hydroxide. The practicability and cheapness of the electrolytic process, and the efficiency of the product, being conceded, we may inquire, lastly, What are the probabilities of this method being superseded by others in the future?

No other white pigment has yet been formed, or seems likely to be found, which will take the place of white lead. The two main substitutes are zinc white, ZnO, and permanent white, $BaSO_4$. But these do not stand the test with white lead, having far less capacity and less covering power. Especially will they not compete with the cheapening of the latter by the new process. Hence, we must look to lead to give us the white pigment of the future.

Now, what are the possible ways of making lead carbonate? There are but three common solvents of the metal: chlorine, acetic acid, nitric acid. Chlorine is at once ruled out for all practical purposes, for reasons that need not be mentioned here. Acetic acid seems to have been the substance universally employed to the present time, for getting the metals into a preliminary state for making the carbonate. As before noted, from the time of Theophrastus to the present day, a host of persons in every age and many countries have experimented and written upon the subject, all using the same method so far as concerns making lead acetate.

The inventor of the present process worked a long time upon the acetate, but as acetic acid is an organic substance of quite complex structure, it broke up very readily under influence of an electric current, giving rise to unendurable fumes, and its use had to be abandoned. For these reasons it is safe to say that no electrolytic process is likely to employ the lead acetates. The only solvent left is therefore nitric acid. Free nitric acid is not likely to be used for three reasons: First, it could hardly be employed in electrolysis; second, it would be more expensive than Chile saltpeter; third, its reaction with lead would give rise to noxious nitric oxide fumes, and its by-product would not be re-usable. It should be said that no gases, except hydrogen, arise in the electrolytic process, in which the acid, as fast as liberated, combines with the lead, as may be seen from equation (2).

Now, the only feasible source of nitric acid yet found is either sodium or potassium nitrate. The former being far the more abundant and cheaper, is here as elsewhere employed, as a source of the acid, and no other nitrates are found to any extent in nature.

It would seem, from what has been set forth, that not only is the process above described the most valuable and revolutionary ever invented for the manufacture of white lead, but that there is not a probability of any other process taking its place in the near future.

This new process was invented in 1892 by Arthur Benjamin Brown, a chemist and mining engineer of Boston. It is to-day for the first time made public. The reason this has not before been done is because time was necessary to complete many details for production on a large scale, and to secure requisite patents. These are now completed, and a large company is authorized to put the process into practical operation. I propose for this invention the name—the Brown Electrolytic Process.

[From Science Progress.]

LOUIS PASTEUR.

LOUIS PASTEUR, one of the scientific leaders of the century, has passed from among us. His personal work is finished, and though the influence which this work will have on the progress of science during the next century cannot at the present time be calculated or foretold, even approximately, we already know how far his investigations have extended our knowledge of molecular physics, altered our ideas concerning certain biological problems, and revolutionized our conceptions of the ætiology and pathology of the specific infective diseases. It may be held by some, as Pasteur himself* held, that the only record of his work that need be kept is that contained in the Comptes Rendus of the Academy of Sciences of Paris, but we are glad to say that a sketch of the life of the man who carried on the great work now inseparably associated with his name has been given to the world by his son-in law, M. Valery Radot, under the title M. Pasteur, Histoire d'un savant par un ignorant.* For many of the facts of Pasteur's life I have drawn freely on this sketch, but the source from which most of the facts relating to his work are taken is that to which he himself would refer his followers—the Comptes Rendus.

Like so many of the greatest sons of France, Louis Pasteur was born, not in one of her great cities, but in Dôle in the Jura, the ancient capital of Franche Comptes, and originally the seat of the University College now at Besançon in the Doubs. His father, a quite, contemplative and studious tanner, was a retired soldier who for his valor had been decorated on the field of battle, married an enthusiastic and ambitious woman, ambitious not for herself or her husband, but for the future of the son who was born to them on December 27, 1822. Father and mother alike determined to make of their son an "educated man;" what success they attained we are now in the best position to form an opinion. Three years after the birth of this son the Pasteur family removed to Arbois, in the valley of the Cuisance, so noted for its wine, where the lad received his early education in the Communal College, the father devoting his evenings to the superintendence of his son's lessons. Like most clever lads, he was not noted for his studiousness at this period, fishing and portrait sketching occupying some of the time and energy that might perhaps have been devoted (with less advantage to the boy probably) to school work. Some of the sketches made at this time, when he was only thirteen, were so clever that it was afterward said of him by an old lady friend: "What a pity that he should have buried himself in chemistry! He has missed his vocation, for he might by this time have made his reputation as a painter." However, Pasteur had a talent for work which could not long lie dormant, and he very soon set himself seriously to master all that could be taught him by his teachers. In order to complete his studies in philosophy, Pasteur went from Arbois, where his interest in chemical study had been kindled by M. Darlay, to the College of Besançon; here, at the end of his scholar's year, he received the degree of bachelier-es-lettres, and was appointed tutor in the college; he was thus able to continue his studies for the entrance examination at the Ecole Normale. In 1842 he passed fourteenth, but determined to devote another year to study for the same examination, with the result that in October, 1843, he was placed fourth on the list of successful candidates. He at once commenced to study chemistry at the Ecole Normale under M. Balard, and at the Sorbonne under M. Dumas, from the former of whom he learned to be enthusiastic and voracious for facts, from the latter a love for precision and exact experiment.

Here, with leisure to read and every encouragement to carry on independent investigation, Pasteur now laid the foundation of his future work, and, under the encouraging direction of M. Delafosse, devoted himself to the study of crystallography, especially in relation to the arrangement of the molecules in these crystals. As Tyndall suggests, probably bearing in mind the properties of rock crystal, and the difference of the facets in the right and left handed crystals, he saw reason in Mitscherlich's note to the Academy of Sciences—the tartrates of soda and ammonia caused the plane of polarized light to rotate to the right, while the paratartrate, which in chemical composition is absolutely the same, causes no rotation—to make a careful search for facets like those that had already been found to exist in rock crystal. Such facets he was able to find in the tartrates, and this being done, he assumed that the want of power of rotating light which existed in the paratartrate must be due to the combination of the opposite rotating powers of right and left handed crystals. He anticipated, indeed, that the tartrate was without a plane of symmetry, while the paratartrate was symmetrical, and that the crystals of the paratartrate would be all characterized by the absence of dissymmetry; on coming to examine the crystals carefully he found, however, that certain of them were dissymmetrical in one way, others in an opposite. "Some of these crystals when placed before a mirror produced the image of the others, and one of the two kinds of crystals corresponded rigorously in form to the tartrate prepared by means of the tartaric acid of the grape," and he argued that one of these forms of crystals must therefore be the one found in the right-handed tartrate, while the other must be something different, and he undertook the laborious task of separating the different kinds of tartrate crystals, placing them in two groups: those like the ordinary right-handed tartrate and those which he found rotated light to the left.

These experiments were carried out during his final year of study in the Ecole Normale, where he took his doctorate in 1847, during the time that he was professor of physical science in the Lycée of Dijon and while he was acting as assistant professor of chemistry in the University of Strasburg. (It was in Strasburg that Pasteur met his future wife—Mdlle. Marie Laurent.)

As a result of these physical and chemical observations, Pasteur conceived the idea that there was an essential difference as regards symmetry between the products of inorganic nature and organic products, the one set having a superposable image, therefore being not dissymmetrical, the others having an image not superposable, and being therefore atomically dissymmetrical, "this dissymmetry expressing itself externally in the power of turning the plane of polarization."

In 1854 Pasteur was nominated dean of the faculty of sciences at Lille, and a new series of investigations was commenced.

It is curious that such a purely physical question as that above outlined should be the real foundation of Pasteur's contributions to the solution of some of the great biological problems that at this time were occupying the minds of scientific men. It was already known that impure tartrate of lime contaminated with organic matter and kept in water would undergo a process of fermentation during which various products were yielded. In order to examine this process Pasteur took about one hundred parts of the pure crystalline right-handed tartrate of ammonia, dissolved it, and added to the solution one part of albuminoid matter. He found that when this was placed in a warm chamber fermentation took place, and the clear solution became turbid, this turbidity being due to the appearance of a number of minute organisms which, following up the analogy of the presence of yeasts in alcoholic fermentation, he assumed must be the cause of this special form of fermentation. He then obtained similar fermentation in a solution of paratartrate of ammonia, when he found that the same organism still made its appearance. Following one of the changes that took place in the fermentation of the two salts with the aid of the polariscope, he found that in the case of the paratartrate, rotation of light to the left could be demonstrated at an early age of the process, from which it was evident that the right-handed tartrate only was being attacked and broken down under the process of fermentation; this was allowed to go on until the deviation to the left had attained a maximum, "the fermentation was then suspended, there was no longer any of the right-handed acid in the liquid, which, when evaporated and mixed with its own volume of alcohol, immediately furnished a beautiful crystallization of left-handed tartrate of ammonia." If, however, he allowed the fermentation to continue beyond this point, the whole of the tartrate was broken down. It was evident, then, that in this case these minute organisms have a power of selecting the special form of tartaric acid and that they have a preference for this, although, when this special form is used up, they fall back on the other and break it down in the same way as they have already used up the first.

In continuing these experiments, Pasteur made the first of that series of experiments by which he was able to corroborate Schwann's experiments designed to prove that no life could be generated from dead organic matter, but that, if certain organisms gained access, even to special forms of inorganic matter, they were capable of multiplying freely; he was able to show that the spores of the Penicillium glaucum, or common mould, could grow and produce the fully formed mould in a solution of paratartaric acid—to which nothing but phosphates of potash, of magnesia, and an ammoniacal salt of an organic acid had been added—first using up the right-handed tartrate and then attacking the left.

Liebig and Gay Lussac had both taught that fermentation and decomposition were due to the action of the oxygen of the air upon nitrogenous substances, and that this process was due to the initiation of certain molecular movements by this process of oxidation, these movements being gradually communicated from particle to particle of the fermentable substance, which was thus resolved into the products of fermentation. Others—Berzelius and Mitscherlich—explained fermentation as the result of the action of a nitrogenous ferment which exerted a catalytic action by its mere presence, adding nothing to the solution and taking nothing from it, but exerting its influence by what these philosophers termed the phenomena of contact. Pasteur was satisfied with neither explanation. Caignard-Latour and Dumas—Pasteur's teacher—both associated the growth of the yeast cell in organic solutions with the process of fermentation that accompanied this growth.

Pasteur made his first experiments on fermentation with milk, in which he recognized, as the process of fermentation went on, the lactic ferment, which he described as little rods with slightly constricted centers, so small that their diameter was scarcely the twenty-five thousandth of an inch. This rod multiplied by a process of division, each one into two shorter rods which, in turn, assumed the shape and size of the original. To isolate this organism and to obtain a comparatively pure culture, Pasteur boiled a little yeast with from fifteen to twenty times its weight of water; he then carefully filtered the liquid, dissolved in it about 5 per cent. of sugar, and then added some chalk.

This he seeded with a trace of the ordinary lactic fermentation deposit, with the result that the next day a lactic acid fermentation had set in, the liquid became turbid, the chalk disappeared, and a deposit of lactic ferment gradually took its place. He then repeated his previous experiment of adding this special ferment to small quantities of crystallizable salt of ammonia and phosphates of potash and magnesia. In this he found also, that although there was no organic matter present beyond that which he had introduced in the shape of his organisms, they still continued to multiply and to give rise to the typical fermentation, both yeast and the lactic ferment acting in the same way, each giving rise to its own special product.

By these experiments both Liebig's and Berzelius' theories were at once shattered, as the carbon was supplied by the fermentable substance, while the process of fermentation could not be due to the action of oxygen on nitrogenous substances, as nitrogenous matter did not enter into the constituents of the solution, and still a vigorous fermentation had taken place. Pasteur concluded that fermentation was simply a phenomenon of nutrition—the nutrient substance being the sugar, the organism nourished being the ferment germs—whether they were lactic acid organisms or yeast—the organisms contriving to obtain the materials necessary for the building up of their complex organization from the sugar and the purely mineral elements.

Then followed the discovery of the butyric ferment,

* Translated from the French by Lady Claud Hamilton: Louis Pasteur, His Life and Work.

which, unlike the lactic ferment, in so far as the organism by which it is brought about—which Pasteur was enabled to separate—exhibits the greatest activity in the absence of oxygen; indeed, when a current of air was passed through the fermenting liquid, the organism—a vibrio—became motionless, fell to the bottom of the fluid, and the process of fermentation ceased. These two organisms were taken by Pasteur to represent two classes: (1) the aerobies or organisms which require a supply of free oxygen in order that they can live and carry on their fermentation function, and (2) the anaerobies, which not only can live without air but flourish best in this condition.

In both cases the organism uses up for its own nutrition a comparatively small amount of the fermentable substance, but decomposes a much greater quantity of this material, breaking it down into what are known as the products of fermentation. He found, however, that yeast could bring about fermentation not only in the presence of oxygen, but also when it was absent, although the amount of decomposition was very different in the two cases. Where no air has access to the organism, a single part of yeast will break down from 100 to 150 parts of sugar; while when oxygen is present it will only break down something like five or six parts, and Pasteur pointed out that in the one case the organism obtains a large part of the oxygen necessary for its growth directly from the air, and therefore does not require to break down so much sugar in order to obtain the elements that it requires for its nutrition; while when air is absent, the oxygen must be obtained from the sugar, as a result of which a very large amount of alcohol is produced during the rearrangement of the molecules rendered necessary by the abstraction of the oxygen.

Various forms of putrefactive processes were then studied by Pasteur, who was able to show that they depended upon organisms similar to those that he had already described in the processes of fermentation, that some of these were aerobic, some anaerobic, that they differed in character according to (1) the nature of the medium to be broken up, and (2) the nature of the organism that was engaged in setting up the special fermentation. He pointed out, too, that one organism would carry on the process of decomposition to a certain stage, while another organism would carry the process a stage farther, so that ultimately the most complex bodies are broken down through the agency of these putrefactive and fermentative organisms into the simplest products, ammonia, carbonic acid and water, the anaerobic organisms doing one kind of work, the aerobic organisms another. He demonstrated that through their agency all organic matter, whether animal or vegetable, as soon as it loses its power of assimilating—in fact, as soon as it dies and becomes effete—is broken down into substances which may be assimilated by plants, living organisms in this way being enabled to live on the dead material that had been stored up by previous generations of these same living organisms.

Pasteur's investigations now, for a time, took a practical turn. The vinegar manufacture, upon which Orleans depends very largely for its industries, claimed his attention. The old process was tedious, uneconomical, and precarious. Pasteur, working at the subject, found that a pure culture of the Mycoderma aceti has the power of taking up oxygen and of transferring it to the alcohol of wine, through which process such alcohol is turned into vinegar. He therefore advised that a pure culture of the Mycoderma aceti should be sown in a mixture of wine and vinegar, and that this should be kept at a temperature of 20° or 25° C. At the end of a couple of days the Mycoderma covers the whole liquid, and in eight or ten days this is converted into vinegar, the process commencing immediately the plant begins to grow. If, however, the process is allowed to go on too far, the vinegar is still further broken down, and ultimately every trace of acetic acid may disappear, this being the result of the action especially of certain anaerobic organisms which continue the process of breaking down, so that ultimately nothing but a foul or odorless and tasteless fluid may remain, each step appearing to be the result of one of these processes to which reference has already been made. These researches gave a new life to the Orleans vinegar manufacture, and at the same time enabled Pasteur to demonstrate that his theory of fermentation, and not that of Liebig, was undoubtedly the correct one.

To-day it seems almost impossible that, only so recently as a little over twenty years ago, the theory of spontaneous generation should have been thoroughly believed in, and that ingenious experiments were made and great ability displayed in defense of this theory as regards the development of living bacteria. Van Helmont's evolution of mice from a pot charged with corn and stuffed with a dirty shirt, and his statement that the smells which arise from the bottom of morasses produce frogs, slugs, leeches, grasses, and other things, are now looked upon as scarcely more extraordinary, although they date back a couple of hundred years.

Having studied the process of fermentation and noted the relation of effect to cause, and having also noticed that the commencement of fermentation and putrefaction processes were invariably associated with the process of seeding out, through the deposition of living organic particles in his nutrient media, he naturally—I say naturally because Pasteur was the observer and logician who was investigating the point under consideration—came to the conclusion that living organisms like all animal and vegetable cells were developed only by a process of reproduction or division of the parent organisms. So many difficulties did the problem "Abiogenesis" appear to present that when Pasteur informed M. Biot that he intended to study this question, the latter assured him "you will never escape from it; you will only lose your time," while his teacher and friend, M. Dumas, said that he would not advise any one to occupy himself too long with such a subject. Pasteur repeated Schwann's experiments of boiling organic fluids and then allowing only air which had been passed over red-hot platinum to come in contact with these fluids, with the result that no evidence of organic life made its appearance even in those which were most decomposable, such as urine. He also showed that on boiling the putrescible fluid in a flask with a long narrow sinuous neck left unclosed, the fluid will remain perfectly clear, and no growth will take place, the moist sides of the narrow neck being sufficient to prevent the entrance to the flask of any solid particulate matter that may be suspended in the air. Such a flask may be kept in an incubator for months perfectly unchanged, but as soon as the narrow neck is nipped off, and particles are allowed to fall in, and with these particles the seeds or germs of moulds or bacteria, these organisms soon make their appearance, and the process of putrefaction goes on apace.

M. Radot says, "Lastly, to convince the most prejudiced minds and to leave no contradiction standing, Pasteur showed one of these bulbs with the sinuous neck which he had prepared and preserved for months and years. The bulb was covered with dust. 'Let us,' said he, 'take up a little of this outside dust on a bit of glass, porcelain, or platinum, and introduce it into the liquid; the following day you will find that the infusion, which up to this time remained perfectly clear, has become turbid, and that it behaves in the same manner as other infusions in contact with ordinary air.' If the bulb be so tilted as to cause a little drop of the clear infusion to reach the extremity of the bent part of the neck where the dust particles are arrested, and if this drop be then allowed to trickle back into the infusion, the result is the same—turbidity supervenes and the microscopic organisms are developed. Finally, if one of these bulbs which have stood the test of months and years without alteration be several times shaken violently, so that the external air shall rush into it, and if it be then placed once more in the stove, life will soon appear in it."

For his work on this subject Pasteur received the prize of the Academy of Sciences, which was awarded to him "for his well-contrived experiments to throw new light upon the question of spontaneous generation."

Tyndall in this country repeated and modified many of Pasteur's experiments, and overthrew in the popular mind the theories that had been advanced by our countryman Needham, although at the time these had been successfully controverted in argument by Spallanzani. Dr.—now Sir William—Roberts and Professor—now Sir Joseph—Lister performed a number of corroborative and additional experiments, with the result that although Dr. Bastian made a most gallant fight in support of the theory of spontaneous generation or abiogenesis, and displayed wonderful ingenuity and ability in its defense, he had ultimately to succumb, and it is probable that in scientific circles Pasteur's demonstrations were more fully accepted as conclusive in this country than in France, and certainly than in Germany, although here Cohn attacked the theory of spontaneous generation with the greatest energy and success. It was at this point that Lister conceived the idea of his now famous antiseptic treatment. He argued that if these germs were necessary for fermentation and for putrefaction, and if they could only be developed from pre-existing germs, might it not be possible by means of mechanical and chemical appliances to prevent their gaining access to wounds in which they must necessarily be the cause of the putrefactive processes that were often developed in them? By the marvelous manner in which he developed methods of keeping organisms from the wounds, he was able to maintain an aseptic condition through which, in old erysipelas and gangrene infected wards, he was able to obtain results which compared most favorably with those obtained under the best hygienic conditions. His method revolutionized surgery, and has, directly and indirectly, been instrumental in saving an incalculable number of valuable human lives. Lister, like Pasteur, was able to apply practically for the alleviation of human suffering the results of researches which in the hands of other men had remained of merely theoretical interest and value.

Having settled this question of a spontaneous generation, Pasteur next turned his attention to a more careful study of the processes of fermentation in wine, and to the wine diseases through which so much wine was rendered of little value and even unsalable. His previous researches, of course, led him to suppose that the disease was due to some special kind of fermentation, the result of the action of an organized ferment. He found that the Mycoderma vini was sometimes present, setting up acid fermentation. The bitter taste sometimes developed was also traced to organized ferments, some of which were merely moulds or mildews. He found that by carefully decanting wines from the lees, and then heating them up to about 140° F. they would keep very well, an organic ferment being destroyed at this temperature, so that if the bottles were carefully corked no decomposition would take place in the wine, which would remain in a perfectly sound condition. This process of Pasteurization, as it is called, has been adopted with success in the sterilization of milk, and of other substances that would be spoiled by being subjected to the action of a higher temperature.

Pasteur's researches on the silkworm disease commencing in 1865 were the first that can be said to have definitely and conclusively proved by rigid experiment the constant connection between a particulate and living organism and a specific disease. Pasteur's previous investigations in the domain of specific fermentations, to each of which he assigned a specific ferment-inducing micro-organism, and his further experiments from which he concluded that not only must there be a living seed from which living organisms, however low in the scale, can spring, but each form of organism must have its ultimate origin in forms like itself, had prepared his mind for this investigation. Before he commenced his work on the silkworm farms at Alais, Pasteur had never even handled a silkworm, but at the request of his old master, M. Dumas, he determined to do what he could to help what was fast becoming a crippled industry on account of the fearful ravages of pébrine among the silkworms. He at once turned his attention to certain small corpuscles that had already been found in diseased silkworms and moths and their eggs by Italian naturalists. It had even been proposed that the eggs of the silkworms should be examined under the microscope in order that only those in which these corpuscles were absent might be hatched, but nothing had come out of this suggestion. Pasteur went to work in his usual methodical but energetic fashion. First the presence of the corpuscles was demonstrated in the egg, the worm, the chrysalis, and the moth. It might sometimes be missed in the earlier stages of development, but in the final form, the imago or moth stage, it could always, if present, be easily enough demonstrated. By a series of feeding experiments the passage of these vibratory corpuscles was traced along with food into the intestine of the worm, then into the surrounding tissues; healthy worms were found to become diseased when they were invaded by these corpuscles. Should a chrysalis stage be reached, instead of a cocoon a mere mass of corpuscles might sometimes be found, while those that reached the moth stage were often crammed with corpuscles to such an extent that they never produced eggs at all; on the other hand, some were still capable of producing eggs, but these eggs in turn, infected from the commencement, could only give rise to diseased worms. Year after year Pasteur, assisted by a band of ardent workers, returned to the attack during the hatching season. His wife and daughter for the nonce became silkworm farmers; forcing houses for artificial hatching were erected, and at last the "peppered" condition of the silkworms (they are mottled by dark patches scattered over the body, hence the name pébrine) was traced to its true cause. It was demonstrated also that these corpuscles could find their way into worms through the wounds made in each other by means of the sharp hooks which are placed at the end of their six forefeet, which, passing over the excreta-infected leaves, and then over the skins of their fellows, transfer the corpuscles that have been voided from the alimentary canal of an infected worm to wounds made in a healthy worm. Although drying renders these corpuscles innocuous, this must, under ordinary circumstances, be continued for several weeks, and the dry dust in the earlier stages of the process still remains capable, if blown about and carried to the mulberry leaves of unaffected farms, of spreading the disease to healthy stock.

What was to be done? The remedy was simple. As soon as the moths have paired they are set apart, each pair on a little piece of linen. As soon as the female has laid her eggs, she is pinned by the wings to the corner of the cloth, where she is allowed to dry. When the leisure time of the silkworm cultivator arrives in autumn and winter, the dried moth is pounded in a mortar, and mixed with a few drops of water. A drop of this is examined under a microscope. If corpuscles are found, the cloth with its little mass of eggs is, along with the contents of the mortar, thrown into the fire; if there are no corpuscles present, the eggs are kept to be hatched when the warm weather returns. In this way worms, cocoons and moths free from pébrine are obtained, and the disease is kept well under control.

A second disease, flacherie, which was found to attack weakly worms, was also traced to its source—the action of microbes taken in along with the food, and setting up a special series of fermentations in the alimentary canal.

Speaking of the precautions to be taken in the selection of silkworms, Pasteur wrote:

"If I were a cultivator of silkworms, I would never hatch an egg produced from worms that I had not observed many times during the last days of their life, so as to make sure of their vigor at the moment when they spin their silk. If you use eggs laid by moths the worms of which have mounted the heather with agility, have shown no traces of flacherie between the fourth moulting and mounting time, and do not contain the least corpuscle of pébrine, then you will succeed in all your cultivations."

The silk industry, which at one time appeared to be on the verge of extinction, was restored to France, which, in consequence, is to-day millions richer. The prolonged strain and the work in the artificially heated cultivating rooms, appears to have told on Pasteur's health, and in October, 1868, when still only forty-five, he broke down, being seized with an attack of paralysis. One side only was affected, but the effects remained to the day of his death. The next year, however, found him again at work at Alais, and then at the Villa Vincentina, near Trieste, on a silk farm owned by the Prince Imperial, at which for ten years the silk harvest had not brought enough to pay the cost of eggs. Under Pasteur's direction the cocoons produced "gave to the villa a net profit of 26,000,000 francs," or over £1,000,000 sterling! All opposition had speedily to give way before such a signal success, and Pasteur's method was finally adopted by the silkworm farmers of all nationalities.

At the close of the Franco-Prussian war, during which, of course, all scientific work ceased, especially as far as Pasteur, who was an ardent patriot, was concerned, he was anxious to recommence his investigations. Again his thoughts reverted to the question of fermentation, especially in so far as it bore on an industry which he thought might be revived in his beloved country. The diseases of beer were, he pointed out, the result of the activity of lactic, butyric, and other ferments which found their way into the wort during the process of brewing, either accidentally or along with the yeast. In order to get rid of these he tried to obtain pure cultures of yeast. In this he succeeded, and so far improved the character of the ferment. Further, by applying his process of Pasteurization—heating in bottle at a temperature sufficient to kill most non-sporebearing organisms—he was able to prevent the development of most of the organisms accidentally admitted, with the result that he practically revolutionized the method of brewing beer, and from a mere rule of thumb process converted it into one strictly accurate and scientific. He ultimately found that when the beer is made with pure yeast and under proper precautions, no extraneous organisms find their way into it at any part of the process, and no Pasteurization is necessary.

This study of beer, however, was merely an interlude, and Robert Boyle's prophecy that "he that understands the nature of ferments and fermentation shall probably be much better able than he that ignores them to give a fair account of divers phenomena of certain diseases (as well fevers as others), which will perhaps be never properly understood without an insight into the doctrine of fermentations," was now about to be fulfilled most completely and literally. Pasteur was not a physician or a surgeon, and it was but natural that the first practical application of his theories of fermentation to the study of disease in the human subject should be made by surgeons. In 1863 Traube, in Germany, pointed out that the alkaline

fermentation of urine does not take place in the bladder except in those cases in which "vibrios find access to the bladder from without." Pasteur had insisted upon this fact, and also pointed out that the fermentation was prevented by the presence of boracic acid. It was therefore proposed that, in cases of operations on the bladder, the parts should be irrigated with a 3 or 4 per cent. solution of boracic acid. Mr. Gavon, who had carried out this treatment at Pasteur's suggestion, obtained marvelous results. In 1865, as already noted, Lister, then professor of surgery in the University of Glasgow, commenced his work on the antiseptic treatment of wounds. In 1874, five years after he had been called upon to occupy the chair of clinical surgery in the University of Edinburgh, he wrote to Pasteur:

"It gives me pleasure to think that you will read with some interest what I have written about an organism which you were the first to study in your memoir on lactic fermentation. I do not know whether you read the British Medical Journal. If so, you will from time to time have seen accounts of the antiseptic system which for the last nine years I have been trying to bring to perfection. Allow me to take this opportunity of sending you my most cordial thanks for having, by your brilliant researches, demonstrated to me the truth of the germ theory of putrefaction, thus giving me the only principle which could lead to a happy end, the antiseptic system."

Surgery was started on the path which has converted it from a mere handicraft to a noble art and a living science; but medicine had not yet been established in the same way, although numerous observers (among them, as Tyndall points out, Dr. William Budd) indicated that the specific epidemic and epizootic diseases were due to the action of seeds or germs which cannot originate spontaneously, but which must be "bred true" from pre-existing organisms, which "are only propagated now by the law of continuous succession."

This brings us to the question of "anthrax," a blood disease, extremely fatal to animals, and often attacking the human subject. It is sometimes stated that Pasteur proved the causal nexus between the bacillus anthracis and anthrax, but although his work undoubtedly stimulated others to investigate the subject, and to investigate it successfully, priority of actual demonstration cannot be claimed for him. His subsequent work on anthrax was, however, perhaps even more important than that which has been claimed for him.

The history of the discovery of the anthrax bacillus and its relation to anthrax may be told in a few words. It was first seen, in 1849, in the blood of an animal that had succumbed to an attack of splenic fever. In the following year Rayer and Davaine described it as occurring under similar conditions, while in 1857 Brauell noted its presence in the blood of a human patient suffering from anthrax. For six years nothing more was done, but in 1863 Davaine, stimulated by the study of Pasteur's observations on fermentation, returned to his investigations on anthrax, and continued working at the subject for ten years, with the result that he was able to give everything but actual proof that the bacillus anthracis was the exciting cause of this malignant disease. At this point Koch took up the work. He applied his plate cultivation method with solidifying media, and after working for some time announced in 1876 that he had been able to furnish most rigorous proof of Davaine's hypothesis. He isolated pure cultures of the organism, described its modes of development and reproduction, pointed out that, under certain conditions, like some of the organisms already described by Pasteur, it formed spores, but that it also multiplied by a process of direct division or fission. During the following year Pasteur also succeeded in growing this organism as a saprophyte. His methods are always as ingenious as they are interesting. It had been found by Davaine that the anthrax bacillus might be demonstrated in a pure condition in the blood of living animals or immediately after death, but that eighteen or twenty-four hours after death the blood was invaded by a second organism, which, inoculated, produced symptoms that could not be ascribed to the bacillus anthracis. Pasteur was able to separate these organisms by making both anaerobic and aerobic cultures from the blood in which this mixture of organisms occurred. In the presence of air the anthrax bacillus only could grow, but in the culture from which air was excluded, only the septic vibrio could develop.

The one organism requires air for its existence, on the other air acts prejudicially.

The anthrax bacillus, he found, would grow readily in certain animals, the ox, the sheep, the rabbit, the guinea pig, not so readily in the dog, while he found that fowls were not at all vulnerable to its attacks. What was the reason for this difference? The answer to this question, as worked out and given by Pasteur, so well illustrates his method of reasoning and procedure that it may be given in some detail. It was found that by subjecting the anthrax bacillus to a temperature of 44° C. (111·2° F.), it was rendered incapable of developing. The temperature of the fowl—41° to 42° C. (105·8° to 107·6° F.)—though not quite so high, may help the tissues to deal with the micro-organism and prevent its development taking place in the body of this bird. "No doubt," he said, "life to a parasite in the body of an animal would not be as easy as in a cultivating liquid contained in a glass vessel." Was this temperature, plus the action of the tissues, the cause of the non-development of the anthrax bacillus? The now classical experiment of cooling the blood of the hen—by placing its feet in water maintained at a temperature of 25° C. until it came down to the temperature of the human body—having previously inoculated the bird with the bacillus anthracis, was made with the result that "at the end of twenty-four hours the hen was dead, and all its blood was filled with splenic bacteria."

The converse experiment was then tried. "A hen was inoculated, subjected like the first to the cold water treatment, and when it became evident that the fever was at its height it was taken out of the water, wrapped carefully in cotton wool and placed in an oven at 35° C.

"Little by little its strength returned; it shook itself, settled itself again, and in a few hours was fully restored to health. The microbe had disappeared. Hens killed after having been thus saved no longer showed the slightest trace of splenic organisms."

In these experiments and the deductions made therefrom we have the groundwork of Pasteur's great work on protective vaccines and vaccination.

Following these experiments, or rather running concurrently with some of them, came the experiments with the microbes of fowl cholera which were destined to have such a tremendous influence on the development of latter-day medicine. In fowls suffering from fowl cholera there had already been described extremely minute micro-organisms which had been supposed by Moritz, by Peroncito, and also by Toussaint, to be the cause of the disease. Pasteur isolated the organism in pure culture, grew it in alkaline chicken broth, and then, by introducing small quantities of the broth culture (the one-hundredth or even the one-thousandth part of a drop) under the skin reproduced the disease in the fowl, and the bird died. Pasteur found that by making successive cultures at short intervals, each new one from that made twenty-four hours before, the virulence of the bacillus of fowl cholera remained unchanged. If, however, a cultivation was kept for some time (three months) protected from dust, but with free access of air, it no longer retained its full virulence, and the birds inoculated with small quantities, though they suffered some illness, did not die.

If, now, after they have passed through this mild attack of the disease, they are inoculated with the non-attenuated fowl cholera virus or cultivation—which before would undoubtedly have killed them—they may have a pretty smart attack of illness, but the majority of them recover. This was the first case in which an experimenter had been able to modify a virus outside the body, and so obtain a protecting virus or one capable of inducing a mild form of disease which would protect against the attacks of a more active virus. The difficulty of obtaining control over the virulence of a disease was overcome when the modified virus had been produced. Well may M. Valery-Radot quote M. Bouley, who said when Pasteur announced his work to the Academy of Sciences: "This is but the beginning. A new doctrine opens itself in medicine, and this doctrine appears to me powerful and luminous. A great future is preparing: I wait for it with the confidence of a believer and with the zeal of an enthusiast."

It was but the beginning: ere long Pasteur was able to produce an anthrax virus so modified by heat that it would not form spores, after which, by treating the micro-organism as he had already treated the fowl cholera bacillus, he was able to obtain an attenuated virus which was capable of setting up a modified attack of the disease, and so of protecting the vaccinated animal against the attack of the more virulent microbe. His successful and striking experiments at Melun have been so often quoted that it is unnecessary to go into them again, but it may be well to point out that out of this work has arisen our knowledge that vaccination against anthrax, and against certain other diseases, can protect most efficiently in most cases and for a considerable length of time: but it is evident that there are cases in which, either through the extreme susceptibility of the patient or the intense activity of the infecting virus, only partial protection is obtained, while even in the most perfectly protected individual the effect of vaccination passes off after a time and leaves the patient again comparatively vulnerable to attack.

Having reduced the virulence of the fowl cholera and anthrax organisms, the next step was to see if their virulence could be restored. In the case of the bacillus anthracis this was done by passing the attenuated form through a very young guinea pig, which, it was found, succumbed to the disease even when inoculated with the weak vaccine; a drop of blood from this animal inoculated into one a little older causes its death, and so on until the blood taken from an aged animal which has succumbed to the inoculation anthrax suffices to kill sheep, and that from the sheep, an ox.

This method of exaltation of the virulence of a virus has since then been used with great effect in the production of active toxins necessary for the production of antitoxins, now so much spoken of. Before leaving this part of our subject, it may be well to point out that it was in connection with the fowl cholera group of organisms that Pasteur was enabled to show that the products of the micro-organisms, from which the micro-organisms themselves had been removed, were capable of setting up many of the symptoms of disease, that they had, in fact, active toxic or poisonous properties. This was a most important step forward, especially as Salmon and Smith, two American investigators, were afterward able to show that in the case of hog cholera the toxins derived from the specific bacillus associated with that disease were, when injected subcutaneously in minute doses or in an attenuated condition, capable of conferring an immunity against the attacks of the micro-organism. We have in these observations the foundation of the "antitoxin" treatment of diphtheria and tetanus, although the full details of the method could not at that time be worked out or even foreseen.

Working at the question of vaccination against swine fever, Pasteur found that when the swine fever organism is passed through several generations of pigeons it gradually becomes more virulent, not only for the pigeon but also for the pig. When, on the other hand, the virus is inoculated from rabbit to rabbit, these animals die undoubtedly, but the blood inoculated into a pig does not set up an acute illness in that animal; it recovers, and is proof against a fresh attack of swine fever. It must be noted, however, that, whether this organism is cultivated in the pigeon when it is most virulent, in the rabbit when it is least so, or in the pig when it is, as it were, in an intermediate condition, there comes a stage in the development of the organism when, if kept to the one species, its virulence remains stationary—it is, in fact, a virus fixé, and will so remain until transferred to another species. This most important observation was destined to bear fruit in the great work on hydrophobia to which Pasteur devoted the last years of his life. Difficulty after difficulty was overcome. Inoculation with saliva failing, through the production of mixed infections, and Galtier having failed to produce rabies by the inoculation of blood from rabid animals, inoculation with cerebro-spinal fluid and portions of the central nervous system was tried; this time the inoculations were attended with success. Then, instead of making his inoculation under the skin merely, Pasteur introduced particles of the brain or cord of an affected animal under the covering of the brain of a healthy animal, with the result that the disease most certainly manifested itself in the inoculated animal, and at an earlier period than when the inoculation was made under the skin. Applying what had been found to occur in swine fever, Pasteur found that canine virus is more powerful than virus that has been passed through a long series of monkeys, while that passed through rabbits gradually acquires such activity that the period of incubation of the disease—i. e., the time which the disease takes to manifest itself after inoculation—is reduced to one-half. Here, then, it was possible to obtain materials for inoculation of all degrees of virulence. Was it not possible by a process of gradual acclimatization of the tissues to the presence of the virus to render a patient immune to the action of the most powerful virus? This was proved, in the first instance, by the use of monkey virus, and then, virus from dogs and rabbits, but all the more recent experiments have been carried on with material derived from the spinal cord of the rabbit. Having observed that the cords of rabbits that had been dead for some time contained a less virulent poison than the cords of freshly killed animals—this being especially the case in dry weather—he came to the conclusion that he might obtain vaccines of all degrees of virulence by simply exposing the cords of rabbits that had succumbed to hydrophobia to dry air for different periods. The fresh cord would give the strongest virus, that exposed longest (fifteen days) the weakest. This was found to be the case, and dogs were protected and cured even when the treatment was commenced only after the animal had been bitten by a rabid animal.

The application of this method to the human subject was first made in the case of a little lad, Joseph Meister, aged nine years, who had been badly bitten by a dog. As the dog was undoubtedly mad, and as there was little chance of the survival of the child in the ordinary course of events, Pasteur resolved, after consulting with Professors Vulpian and Grancher, who agreed to share the responsibility, to treat the boy as he had treated the dogs that he had already been successful in protecting. The boy recovered, and since that time there can be no doubt that, although there may have been certain failures, a great number of lives have been saved which otherwise would inevitably have been lost.

This investigation brought Pasteur's active experimental work to a conclusion, though he was in constant attendance at the laboratories in the Rue Dutôt or in those connected with the stables at Garches, situated in the park of the Old Château de Ville Neuve l'Etang, where the work on hydrophobia and diphtheria is carried on, guiding, advising, directing, and watching with keen interest the work of his pupils, encouraging them to overcome difficulties, and rejoicing with them in their successes. He thus practically died in harness, for it was at Garches after about three weeks severe illness—he had been ailing for some time—that he died on the 29th of September.

Pasteur married the daughter of M. Laurent, the rector of the Strasburg Academy. His son, Jean Baptiste, is in the diplomatic service, and his only surviving daughter, Madame Valery-Radot, is the wife of the biographer of the great man.

It is difficult to sum up in few words the character of such a man. Those who have come in contact with him were always struck by his energy, directness, and simplicity; those who have followed his work, by his industry, his pertinacity, his clearsightedness, his wonderful powers both of experiment and of deduction, and by that power of induction which, among scientific men, is found only in those who may lay claim to genius. When, on the occasion of the celebration of his seventieth birthday, Pasteur's admirers and disciples, collected from almost all civilized nations, met to do him honor, Sir Joseph Lister, presenting what might be called an international gold medal, spoke to the following effect, he was but giving utterance to what every man sitting in the Sorbonne felt most sincerely. He said:

"There is certainly not in the whole world a single person to whom medical science is more indebted than to you. Your researches on fermentation have thrown a flood of light which has illuminated the gloomy shades of surgery, and changed the treatment of wounds from a matter of doubtful, and too often disastrous, empiricism into a scientific art, certain and beneficent. Owing to you, surgery has undergone a complete revolution. It has been stripped of its terrors, and its efficiency has been almost unlimitedly enlarged. But medicine owes as much to your profound and philosophic studies as surgery. You have raised the veil which had for centuries covered infectious diseases. You have discovered and proved their microbic nature; and thanks to your initiation, and in many cases to your own special labor, there are already, a host of these destructive diseases of which we now completely know the causes. This knowledge has already perfected in a surprising fashion the diagnosis of certain plagues of the human race, and has marked out the course which must be followed in their prophylactic and curative treatment. Medicine and surgery are eager on this great occasion to offer you the profound homage of their admiration and their gratitude."

Whatever may be Pasteur's claim to honor, and how fully that claim is accepted Lister's words convey, it will, in future, perhaps, even more definitely than it does at present, undoubtedly rest upon the work which he has done in elucidating the questions connected with the ætiology and prophylaxis of specific infective disease. This one idea is the root from which his work branches out in all directions. One line of thought, work, and reasoning was followed throughout. Each step in this path was carefully probed and tested before any further advance was made, and once gained, was never left until it had been made thoroughly sound as a point from which the next step might be made. This it is that makes his work so reliable, and assures for it the immortality to which only truth can attain.

Pasteur was a patriot, and France is to-day poorer

than when her great son was alive; but the loss that science of all nations has to bear is infinitely greater, not because his work will perish, for that can never come to pass, but because he can no longer work except through those who, during his lifetime, have been his pupils, friends, and assistants. They, however, have already given proof that we may not look in vain to them for the continuation of the noble work that their master commenced.

GERMAN SIMS WOODHEAD.

FURNACE FOR TOWN REFUSE.

By S. WILLOUGHBY, Chiswick, Middlesex, England.

THE destructor is shown in vertical section in the figure. The refuse is fed into the hopper, c, and is conveyed by the screw into the vertical cylindrical shaft, a, having perforated walls. This is surrounded by the annular furnace, b^1, supplied with air blast from the annular box, b^4, and the heated gases from this furnace, passing through the perforations, a^2, consume the refuse, and the products of combustion pass through water spray from the sprinkler, d^1, and escape into the chimney.

THE DIPHTHERIA OF FOWLS AND ITS RELATION TO PUBLIC HEALTH.

A BROCHURE entitled Investigations concerning Infectious Diseases among Poultry has recently been issued by the Bureau of Animal Industry. It is made up of four valuable articles, headed: An Infectious Disease among Turkeys caused by Protozoa (Infectious Entero-hepatatis), A Preliminary Investigation of Diphtheria in Fowls, A Study of a Bacillus obtained from Three Outbreaks of Fowl Cholera, and On a Pathogenic Bacillus of the Hog Cholera Group associated with a Fatal Disease in Pigeons. The first of these articles is by Dr. Theobald Smith; the others are by Dr. Veranus A. Moore.

Dr. Moore concludes from his investigations and from the published statements of a large number of poultry raisers that the diphtheria of fowls can be prevented, and if introduced into a flock, can be cured. Although, he says, it will be necessary to determine experimentally the efficiency of curative agents on a considerable number of fowls before formulas for treatment can be laid down, several important suggestions present themselves, especially in reference to preventive measures. In order to prevent this disease, says Dr. Moore, many conditions must be strictly complied with. The character of the food and the general sanitary conditions, including cleanliness, ventilation, and the temperature of the poultry houses, must be considered, he says, and he thinks there is much to be learned in connection with the proper care of poultry, especially in rural districts, where it is probable that many methods now in use will, after a careful investigation, be found defective.

The determination of these details, he adds, must necessarily be made by those actually engaged in the raising of poultry. In addition to general sanitary methods, he thinks the following rules should be observed: 1. Fowls which have an exudate on any of the mucous membranes of the head, or which have come from flocks in which such a disease exists or has recently existed, should not be introduced among other poultry. 2. If the disease appears in one or more fowls of a flock, they should be separated from the well ones immediately. If possible, the source of the infection should be determined and removed. 3. The quite common practice of allowing fowls from different flocks to run together during the day should be discouraged. 4. Care should be taken to avoid the possibility of bringing the virus of the disease from affected flocks in the dirt or excrement which naturally adheres to the shoes in walking through an infected chicken yard. The same care is necessary in the interchange of working implements, such as shovels, hoes, etc.

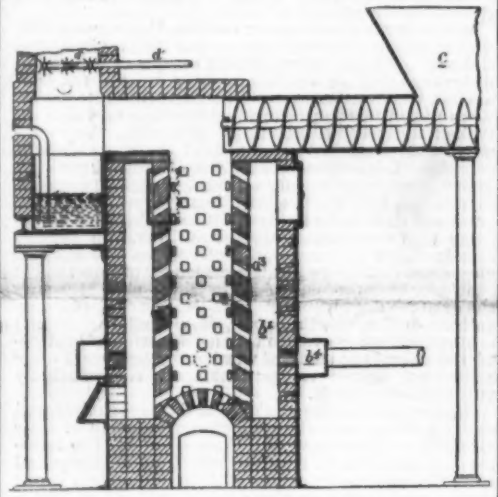
Dr. Moore remarks that the diphtheria of fowls is one of the few diseases of poultry for which curative measures promise to be of practical value. The practice of destroying all the affected birds should be discouraged. Although, says Dr. Moore, experiments have not been made to test the efficiency of remedies already recommended or to investigate the practicability of others, the testimony of many practical poultry raisers is to the effect that the disease is amenable to treatment. The most efficient of the known methods of treatment, he thinks, is the local application of certain disinfectants, among which a weak solution of carbolic acid appears to him the most satisfactory. The fact that the lesions are so exposed renders the disease especially favorable for topical applications. The administration of mild stimulants also has been recommended.

In addition to the medicinal treatment, it is of much importance that the affected fowls be provided with proper food and kept in dry, warm, and well ventilated apartments. In the course of his study a considerable number of badly affected fowls fully recovered in the animal room of the laboratory with no treatment other than being kept in a warm, dry atmosphere. It is frequently necessary to remove the exudate before the application of the disinfectant. A few fowls that evidently would have soon died from starvation or a closure of the respiratory passages were immediately relieved and cured by removing the obstructing exudate. Certain disinfectants and stimulants, Dr. Moore is advised, will give good results, if administered early in the course of the disease by mixing them with the food, and thus eliminating the necessity of individual application.

A comparison of the Klebs Loeffler bacillus as found in man with the one described by Loeffler as the cause of diphtheria in fowls shows, says Dr. Moore, that morphologically and in their pathogenesis for experimental animals the two organisms are in no way alike. There is also, he adds, a marked difference in the nature of the exudates in fowls and in man, and the diversity of the two diseases has been clearly pointed out by Ménard. But, although these diseases are shown by several observations to be unlike in their etiology and the character of their lesions, the transmission of fowl diphtheria to the human species, and vice versa, is affirmed by several writers. Dr. Moore cites instances reported by Gerhardt, Debrie, Cole, Loir and Ducloux, Ménard, and Schrevens.

Although, says Dr. Moore, the number of reported cases of the transmission of fowl diphtheria to the human species, and vice versa, is small in comparison with the extent of the disease in poultry, the evidence that such a transmission is possible is quite sufficient to discourage the careless handling of diseased fowls. It is a quite common practice, especially in the rural districts, to bring the sick chickens into the house for treatment, where the children of the household are allowed to fondle them at will. It is not improbable, Dr. Moore thinks, that when this disease is thoroughly investigated the number of cases of direct infection from this source will be found to be much larger than is at present supposed. Until such investigations are satisfactorily completed, he adds, the indiscriminate handling of diphtheritic chickens, especially by children, and the exposure of fowls to the infection of diphtheria in the human species, whereby they may become carriers of the virus, should be strenuously avoided.

Dr. Moore summarizes his conclusions as follows: 1. Many of the so-called diseases of fowls which are characterized by an affection of the mucous membranes of the head, and popularly designated as "roup," diphtheria, influenza, and sometimes cholera, resemble each other so closely in their manifestations that they may be considered as belonging to one and the same disease. This disease is distinct from the rapidly fatal malady which is better known as fowl cholera. 2. The lesions, as usually encountered, are diphtheritic in nature. In the advanced stages the accumulating exudates decompose and emit a putrid odor. In the earlier stages they are frequently of a serous or muco-purulent character, and not infrequently fowls die before the diphtheritic condition appears. 3. The same species of a pathogenic bacillus is associated with apparently different forms of lesions, more particularly in the serous or muco-purulent and diphtheritic. This bacillus is not distinguishable from the one described by European writers as the cause of fowl cholera, and cannot be distinguished in parallel cultures from the bacillus of swine plague. It is comparable in certain respects to the supposed specific organisms of certain diphtheritic diseases of poultry and birds. Its causal relation to this disease, however, is not demonstrated. 4. This disease usually runs a slow, chronic course



DESTRUCTOR FOR TOWN REFUSE.

from which the majority of the affected fowls recover. Its long duration enables the lesions to be more or less modified from the effect of external contamination. Outbreaks in which the disease runs a rapidly fatal course are reported, but thus far they have not been encountered in the investigations of the bureau. 5. This disease, or, as may subsequently be found, these diseases is, or are, amenable to treatment. The treatment consists largely in good hygiene, and the removal of the accumulated exudate when the disease has reached the advanced stage. The local application of disinfectants is indicated. 6. A large number of slight or severe enzootics among fowls, due to local unsanitary conditions, are popularly considered as outbreaks of some contagious disease. 7. Judging from the results of these investigations and the recorded experience of certain poultry raisers, it is highly probable that this malady would have been prevented in a large proportion of the flocks in which it now exists if careful sanitary methods had been followed and precautions taken against the introduction of the disease through the purchase of affected fowls.

We have given Dr. Moore's observations and deductions almost in his own words. Their importance can hardly be overrated.—N. Y. Med. Jour.

AMALGAMATED ALUMINUM—USE AS A NEUTRAL REDUCING AGENT IN PRESENCE OF WATER.

ALTHOUGH it has been long known that water is rapidly decomposed by amalgamated aluminum, very little use has been made of the discovery. According to the authors, however, the material is eminently adapted for use as a reducing agent, more particularly for the purposes of organic research. Amalgamated aluminum has no action on absolute alcohol and ether, but traces of water, if present, are at once attacked with liberation of hydrogen. Obviously, therefore, by its means these solvents may be readily brought to the anhydrous state. Moreover, amalgamated aluminum possesses over sodium, etc., the advantage that it is more under control; while the product of its oxidation (alumina) is an indifferent body. Solutions of nitro bodies, etc., in absolute alcohol or ether, are treated with amalgam, and water added drop by drop until reduction is complete. The alumina formed is readily separated by filtration and retains very little of the solution. By varying the conditions of experiment, as regards temperature and proportion of amalgam used, intermediate reduction products may be obtained. Nitrobenzene, for example, may be reduced completely to aniline, or partially to β-phenylhydroxylamine. The process is also well suited for the hydrogenization of unsaturated carbon compounds—especially of the aromatic series—ketones, lactones, etc. The amalgam is prepared as follows: Aluminum shavings (freed from oil, grease, etc.) are treated with soda solution until hydrogen is given off briskly, then slightly rinsed with water, and steeped for 1–2 minutes in a ½ per cent. sublimate solution. These operations are repeated to thoroughly get rid of scum and dirt, and the metal finally washed consecutively with water, alcohol, and ether, and preserved for use under petroleum spirit.—H. Wislicenus and L. Kaufmann, Ber. 1895, 28, 1323–1327.

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